CONTENTS

FOR ENGINEERS AND CONTRACTORS CONTROLLING THE DESIGN, SPECIFICATION, INSTALLATION AND MAINTENANCE OF HEATING, VENTILATING AND AIR CONDITIONING.

HEATING & VENTILATING

AIR CONDITIONING

FOR MARCH, 1939

The Prediction of Noise Levels from Mechanical Equipment . 23

Free Steam for Italy 26

Data on Heat Output of Poultry 27

Practical Heating Experience with Income Properties . . 30

Pressure Drop in Refrigerant Suction Lines. 32

How to Prevent Fire Hazards in Conditioning Systems . . 34

Number of Hours per Year of High Dry Bulb Temperatures . 35

Check List for Air Conditioning Servicing 39

Steam Piping Connections for Convectors 44

Let the Contractor Beware of Letters 46

Reference Data, 145 and 146. 46

Standards for Mechanical Draft Oil Burners 47

The Flow of Air and Its Distribution Through Ducts—2 . . 49

Contractors Want Larger Drawings 52

Simple Method for Obtaining Degree-Days 53

Physiology for the Air Conditioning Engineer 55

Editorials 57

Abstracts 58

News of the Month 60

New Equipment 69

Degree-Days for January, 1939 74

With the Manufacturers 76

New Trade Literature 77

Coming Events 79

THIS MONTH:

WATCHING HEATING COSTS *of income-producing properties is explained in an article on page 30, which shows how one concern managing a number of properties kept track of fuel and other heating costs of its buildings.*

HEAT OUTPUT OF POULTRY. *The air conditioning engineer is always interested in the heat output of any heat-producing bodies maintained in conditioned structures. The Department of Agriculture is measuring poultry metabolism in an air conditioning laboratory, described on page 27.*

OIL BURNER STANDARDS. *In the middle of March the Bureau of Standards will sponsor a meeting in Washington with the object of establishing commercial standards for mechanical draft oil burner design and operation. These standards are presented in full on page 47.*

FIRE HAZARDS *in connection with air conditioning is the subject of an article on page 34 by an engineer with the National Board of Fire Underwriters who gives practical hints on how to prevent such hazards.*

EXCESSIVE NOISE *is the bugbear of air heating and cooling installations where sound levels are of great importance. The author of an article on page 23 indicates how certain sound problems can be solved and how the sound level can be reduced to a desired point.*

Copyright, 1939, by The Industrial Press

HEATING & VENTILATING is published monthly by The Industrial Press, Robert B. Luchars, President; Edgar A. Becker, Vice-President and Treasurer; Erik Oberg, Secretary. Published at 148 Lafayette Street, New York, N. Y. Western Office, 228 North La Salle Street, Chicago, Ill. Yearly subscription in United States, Spain, South America, Mexico, and Canada, $2.00; in all other countries, $3.00. Single copies, 30 cents. Member of Audit Bureau of Circulation and Associated Business Papers.

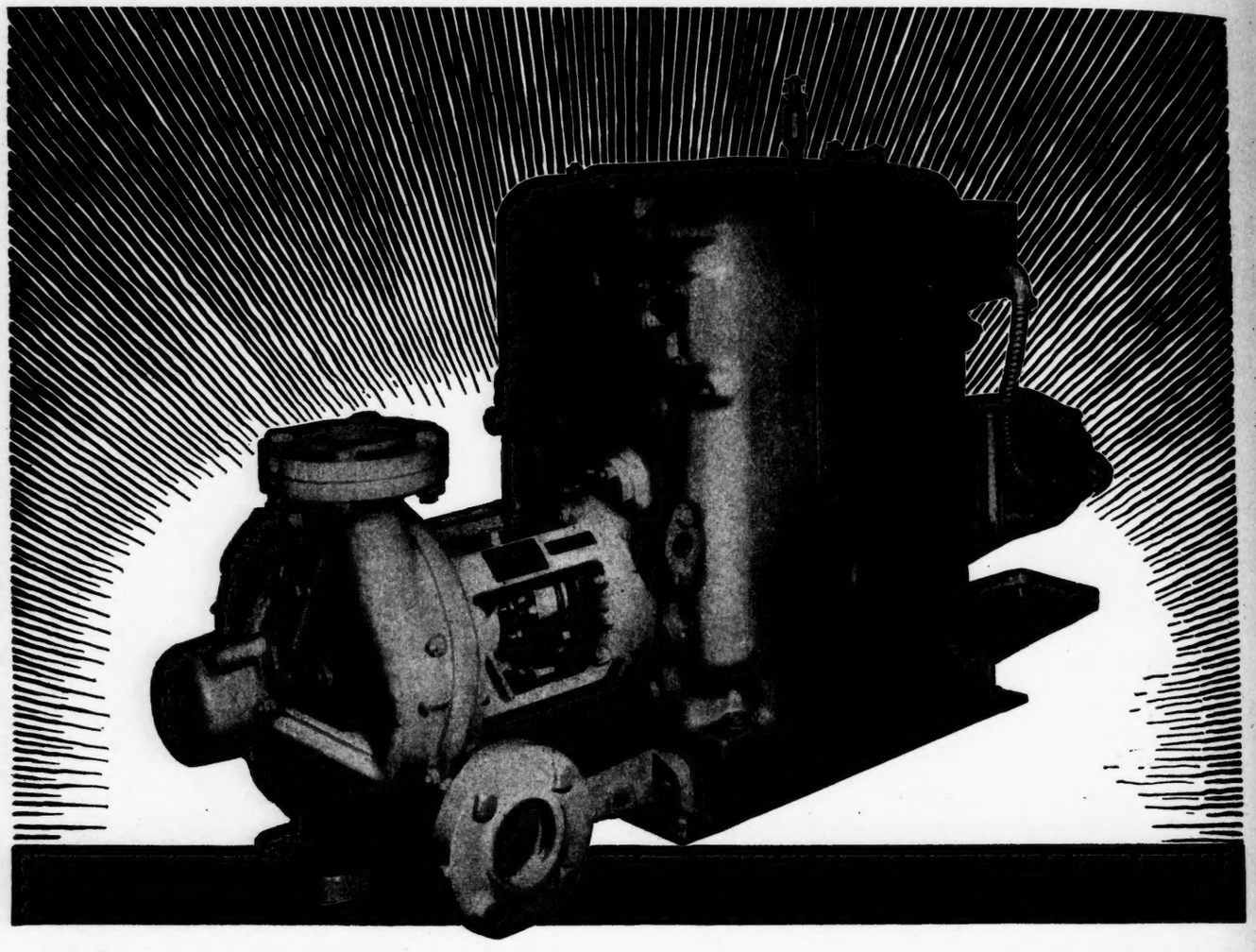
VOLUME 36 NUMBER 3

EDITORIAL STAFF

Editor
C. H. B. HOTCHKISS
Associate Editor
CLIFFORD STROCK
Assistant Editor
JOSEPH F. KERN, JR.

Safety!

THE NASH VAPOR TURBINE HEATING PUMP IS NOT STOPPED BY ELECTRIC CURRENT FAILURE



For service in greenhouses, hospitals, schools, theatres, and public buildings, where heat failure is a serious matter, the Nash Vapor Turbine Return Line Vacuum Heating pump should be specified, for this pump operates perfectly without electric current.

This is because the motive power is a special turbine operating on steam direct from the heating system. Steam used to drive the Vapor Turbine is returned to the system for heating, with little heat loss.

This pump insures constant heat in the system, it eliminates electric current cost, and it promotes high efficiency in the heating system. Heating efficiency is due to the fact that this pump can operate continuously with economy. Continuous operation means uniform circulation, and uniform conditions in the system mean steam saving.

This pump has but one moving part, no internal wearing parts, and requires no internal lubrication. Bulletin D-246 tells all about it, and it is free on request.

THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

The Prediction of Noise Levels from Mechanical Equipment

By JOHN S. PARKINSON†

In many instances sound levels are of importance in air heating and cooling installations. The equipment installed should not add to the noise which would be present if there were no air conditioning system. How to be sure that this situation will be brought about is a difficult problem because of lack of information and of simple methods of predicting sound levels. Here the author indicates how certain sound problems can be solved and how the sound level can be reduced to a desired point in certain instances.

IT is often important for the heating and ventilating engineer to be able to predict the noise level which will be generated by his equipment in a given location. This information is always desirable in order to produce comfortable living and working conditions; and in some locations, as in radio studios and sound film studios, it is essential to the design. In the belief that such data will be important as customers become more noise conscious, various investigators have been studying different angles of the problem. The information at hand is still decidedly limited, but it is gradually becoming possible to fill in the picture.

Two Classes of Equipment

The equipment to be considered falls roughly in two general classes—that which is located in the room to be conditioned, and that which is located at some remote point and connected by ductwork to the room. To make accurate predictions for the first group it is necessary to know how much sound is radiated by the unit under a known set of acoustic conditions. This is a problem which manufacturers are beginning to answer in their own laboratories. There is evidence that the noise rating will probably be given in terms of some typical room suitable for the capacity of the equipment in question. Thus, for example, if the unit is a room conditioner designed to handle private offices, the noise rating will be the average noise level which this unit may be expected to generate in a typical private office. The noise level in this typical room will be governed by one single acoustical quantity—the absorbing power of the room in sabines. This is computed by multiplying the square foot area of each surface in the room by its sound absorption coefficient, and summing these absorptions, with the necessary additional allowance for furniture and fixtures.

Since the absorbing power of a room is proportional to the area of its interior surfaces, and since most offices and living quarters have ceiling heights of about nine feet, it is possible to arrive at an approximate proportionality between the dimensions and the probable absorbing power of the room. As we have pointed out, this absorbing power determines the noise level which will be generated. In Fig. 1 these variables are assembled in a single graph. As an example of the method of using the graph, assume that the rating of a certain unit is given as 40 decibels* in a room having 100 sabines, or absorption units. It is desired to install the unit in an office having dimensions 20 by 30 ft. Enter the graph from the left at width equals 20, and find the point at which this horizontal line intersects with the vertical corresponding to length equals 30. The hyperbolic line corresponding to this intersection gives 170 as the number of units in the room. Now enter the graph from the top at 100, the number of units in the room where the original rating was made. Find the intersection of this vertical line with the hyperbolic curve previously determined, and read the diagonal line corresponding. This will give the correction factor which must be applied to the rating in order to arrive at the probable level in the proposed room. This correction factor is –2.3 decibels, indicating a probable level in the proposed room of 40–2.3 = 37.7 db.

*Terminology used herein is that given in ASA Tentative Standards for Acoustic Terminology Z24.1.

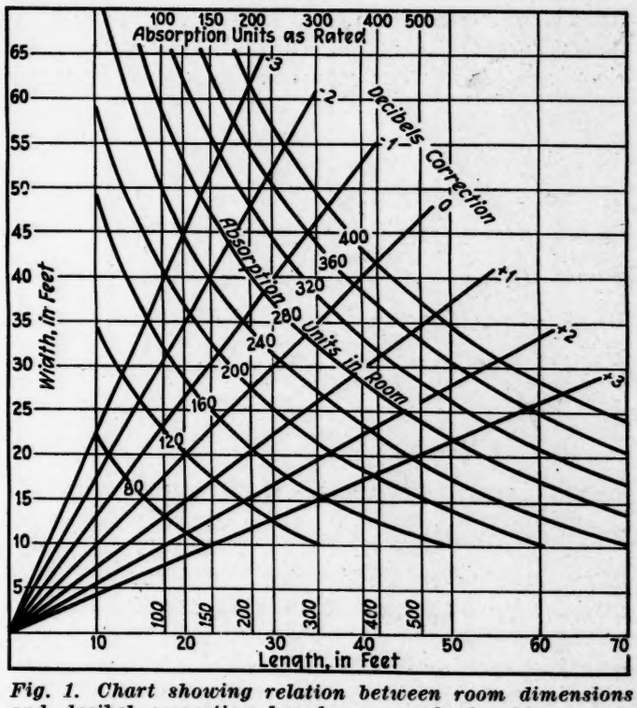


Fig. 1. Chart showing relation between room dimensions and decibel correction based on sound absorbing power of room.

†Acoustical Engineering Section, Johns-Manville Research Laboratories.

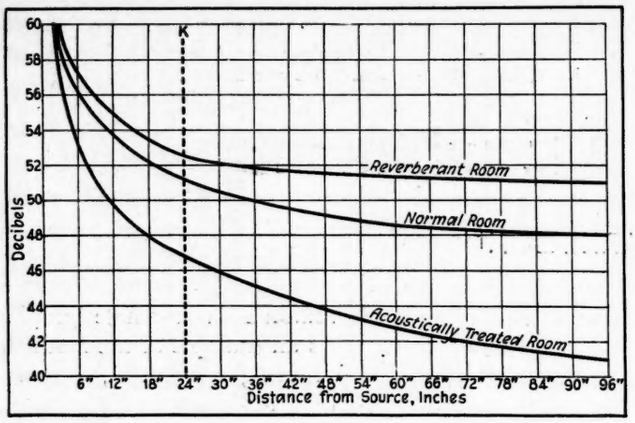


Fig. 2. Relation between sound level and distance from source of equipment sound in several types of rooms.

Note that the assumptions involved in this calculation should be clearly recognized. The first is that of normal ceiling height, and the second of normal furnishings. If the room is higher than normal or more elaborately furnished the absorbing power will be greater than that indicated by the graph. Likewise, if there is acoustical treatment on the ceiling or walls an additional correction is necessary. For treatments of normal efficiency, this would mean deducting about five or six decibels more from the predicted level.

Some manufacturers rate their equipment in terms of the sound level at a certain point a few feet from the apparatus. This type of rating is useful in *comparing* different pieces of equipment of the same size and type, but such readings are of little or no value in predicting general noise levels. If the sound level at a point immediately adjacent to the equipment is measured, and then at successively greater distances, the readings will decrease and will follow in general an exponential curve (excepting possible variations due to sound pattern at certain points) until they approach a constant minimum level characteristic of the room. Fig. 2 shows three typical curves of this type. They were taken for a small electric motor in three rooms having different acoustic properties, with absorbing powers varying approximately in the ratio 1-2-6. It will be seen that a measurement taken at some random point near the apparatus, such as the point *k* which is 24 in. away, has no significance, since it will vary depending on the space chosen for the test.

The shape of the curve will be governed by the acoustic properties of the room, as indicated by the figure. The only predictable points on these curves are the origin at the equipment, which is common to all curves, and the levels at which they asymptote. The former is of little practical value since the average listener will never be this close. The latter, however, since it is characteristic of the entire space, exclusive of the area immediately around the equipment, has real usefulness. It is to be hoped that manufacturers will adopt rating procedures which will permit this general room level to be stated. This may be done in the manner described above, by measuring the level created by the equipment in a space of known acoustic properties and then making the correction for the space under consideration. Or it may be done by measuring the total sound energy output of the unit and calculating the level which will be set up in any given case. The latter is perhaps the more generally useful method, but it is too complex for detailed discussion here.

The method of measuring the noise level at some fixed point near the equipment has the advantage of providing a definite test procedure which does not involve any calculation, nor any assumptions as to the acoustic properties of the room. However, it provides no information as to the average room level which will prevail at a distance. All that can definitely be stated is that the room level will be lower.

Noise Carried through Ducts

Apparatus which is located at a point remote from the occupied space usually creates a noise problem only insofar as the noise which it generates is transmitted through the connecting ductwork. In order to predict how much noise will be radiated into the conditioned space, it is necessary to know first how much sound energy enters the duct from the equipment end, and second, how much of this energy is dissipated as it travels through the duct system. There are very little exact data on the first point. Such information as there is indicates that the input levels will be in the neighborhood of 90 to 110 decibels, depending on the type, size, and speed of the apparatus. These measurements were made on units having from 5000 to 20,000 c.f.m. capacity. They refer to the energy flux per unit area of outlet or inlet, and consequently do not increase with increasing size as rapidly as would a total energy measurement. The propeller type units probably fall in the higher part of this range, although there will be exceptions.

Somewhat more is known about the dissipative effects within the duct system. These are in general of two kinds—absorptive and reflective. Under absorptive effects are included the energy which goes into vibration of the duct walls, some of which is radiated outward, and absorption by sound absorbent lining materials. Reflections occur at bends, elbows, splitters, and at any abrupt changes in area. These reflections affect primarily the low frequencies; i. e., those below 500 cycles, which are characteristic of the noise from fan and motor. The high frequencies which are characteristic of air rush do not seem to be as much affected by the design of the duct system, except insofar as one design may produce more turbulence than another.

There are a number of rule-of-thumb procedures followed for determining the losses in a duct system. Allowances for bends and elbows range from 1 to 3 db. each, with even larger allowances being made for changes in area, as where a side duct branches off from a main supply duct. Strictly speaking, of course, these losses are not "dissipative" at all, but they may be included in the calculation of the total loss, because they represent energy which will not reach the room. There are also losses in a straight run of unlined duct due to absorption in and transmission through the walls. There are at present no experimental measurements on this class of dissipation, but it seems probable that an approximate idea of their magnitude can be obtained by allowing 10 to 15% absorption coefficient for these walls and computing the corresponding reduction from Fig. 3.

On this basis the reduction in an 18 by 18 in. duct, for example, would be 0.12 to 0.26 db. per ft. of length.

Probably the most effective way of reducing sound transmission through ducts is by the use of sound absorbent linings. Lining materials are available which will absorb up to four or five decibels per foot at certain frequencies, without introducing any added complications in design in the form of fire hazard, moisture absorption, or other particulars. Certain of these add very little to the total air flow resistance of the system. In one case, where measurements are available, the resistance has proved to be only 16% greater than that of the unlined duct. Because the attenuation due to these lining materials is so much greater than any other known to be present in duct systems, it has been investigated much more exhaustively.[1, 2] In an earlier paper, the author attempted to set down a relationship between the four factors which are known to affect the attenuation produced by lining materials. This was done by drawing an analogy between the two dimensional dissipation occurring in a duct system and the three dimensional case characteristic of a room. Further study and the work of other investigators has led to some modification of this theory.

There seems to be both experimental and theoretical justification for assuming that the attenuation per lineal foot of lined duct expressed in decibels is a constant for all lengths, providing the frequency spectrum of the sound remains constant. The original work indicated this, and Sivian's analysis, which assigns "a propagation constant per unit length of line," makes the same assumption. In cases where the attenuation of Sivian's experimental system is high enough to make terminal reflections negligible, he states that "the observed pressure amplitude loss per unit duct length may be identified with the attenuation constant."

Taylor and Sherwin[2] found that for a 5-in. flue lined with sound absorbent material "the curve shows practically . . . a uniform reduction in intensity per unit length throughout the length of the flue. . . ." Their theoretical analysis derives an expression for the attenuation in decibels per square foot of duct lining, which of necessity requires uniform reduction per unit length.

None of these investigators, however, seems to provide a simple general formula including variables other than the length; i.e., duct size, the absorption coefficient of the lining material, and the frequency. There is considerable evidence, although it is not conclusive, that for commercial types of duct lining materials no correction for frequency need be made other than to allow for the variation of the absorption coefficient, providing that the wave length is more than the dimensions of the duct. Thus in ducts of the order of a foot square a general expression can probably be derived covering the range up to 1000 cycles. Such an expression has been developed empirically, and is the basis for Fig. 3.

This graph shows the attenuation expressed in decibels per lineal foot of duct for varying sizes of square ducts. (It is probable that no great error is introduced in the case of ducts which do not depart too far from the rectangular by reducing them to the equivalent square shape.) It will be seen that the sound attenuation increases as the size of the duct decreases, and also with larger coefficients of sound absorption. This graph coincides well with most of the experimental data reported on loud speaker tones. For calculating reduction in fan and blower noise, it is suggested that the coefficient of the material given for 256 cycles be used in making calculations, as an approximation.

Again in connection with the curves of Fig. 3 a word of caution is undoubtedly necessary. The only claim which may be made for them is that they appear to fit most of the available experimental data. As more information is obtained, particularly information on actual duct systems, changes in the form of the curves will probably be necessary. There seems good reason to suppose, however, that such changes will not be of a radical nature unless some fundamental change is made in the nature of the materials themselves.

For frequencies whose wave length is small compared to the duct dimension a somewhat different procedure is necessary. These will be greater than 500 cycles in almost all cases. Such frequencies are produced almost exclusively by air friction and turbulence as the air passes through the duct system. These can

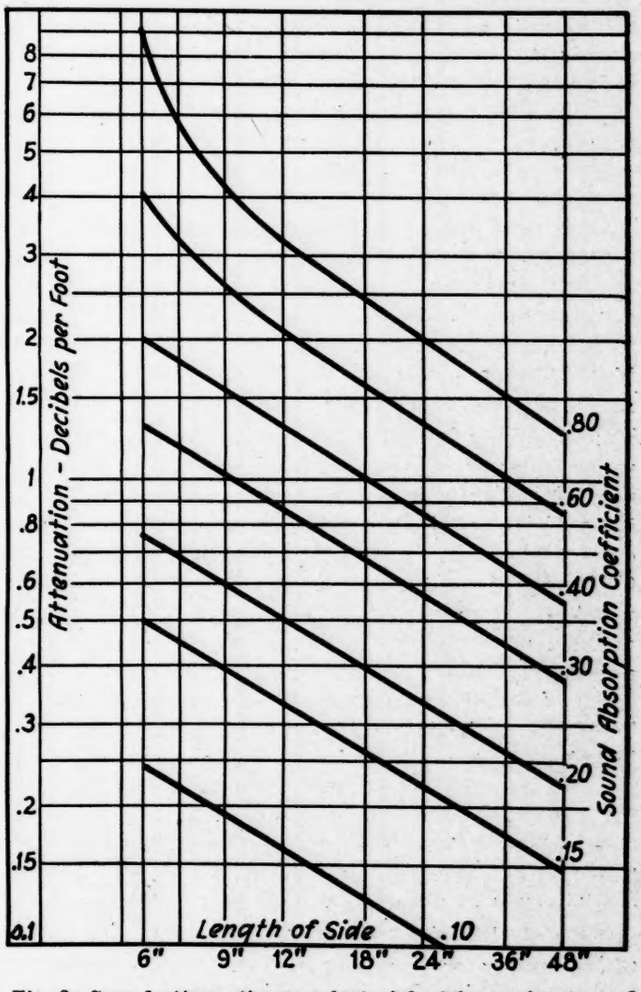


Fig. 3. Sound attenuation per foot of duct for various sound absorbing duct liners in approximately square ducts.

[1] "Sound Propagation in Ducts Lined with Absorbing Materials," L. J. Sivian. Journal of the Acoustical Society of America, Vol. 9, No. 2, October, 1937.

[2] "Sound Absorption and Attenuation by the Flue Method," H. O. Taylor and C. W. Sherwin. Journal of the Acoustical Society of America, Vol. 9, No. 4, April, 1938.

usually be handled by treating a length at the outlet equivalent to ten times the average duct dimension (or diameter). The reduction produced by the lining at these frequencies is non-linear with length, the greatest reduction being obtained in the first few feet of lining. It is not ordinarily economical to increase this length of lining much beyond the ten diameters specified because the additional reductions in high frequency noise obtained thereby are small.

To illustrate the method of using the data above, consider one of a suite of small offices served by a multi-blade blower of 8000 cu. ft. capacity. Between the blower and the outlet are 30 ft. of 24 by 24 in. duct with two elbows, 30 ft. of 15 by 15 in. duct with one elbow, and the branch duct to the office is 8 by 10 in. 10 ft. long with one elbow. We estimate the noise at the blower outlet to be represented by an intensity flux of 95 db. above threshold. Four elbows will bring this level down approximately 8 db. Two changes in area, plus that at the grill opening, will add another 10 db. Thirty feet of unlined duct 24 in. square and 30 ft. 15 in. square, with an assumed absorption coefficient of 12½%, will produce another 10.8 db. reduction. (Enter Fig. 3 at $s = 15$ in., read up to the diagonal line corresponding to $a = 12½\%$, and read across to the decibels drop per foot at the left. This gives 0.22 db. per ft. at 15 in. square and 0.14 db. per ft. at 24 in. square. Ten feet of 8 by 10 in. duct, will cause a drop of 1.9 db.) The noise at the outlet may thus be expected to be of the order of $95 - (8 + 10 + 10.8 + 1.9) = 64.3$ db. In the office itself the average level at the point where occupants are located will probably be 10 db. less than at the duct outlet, or say 54.3 db. (In large rooms this difference, due to diffusion and absorption of the sound through the room, may be as high as 20 db.)

The table of anticipated noise levels in the ASHVE Guide for 1938, page 585, gives 45 db. as a representative level for private offices. This means that another 9.3 db. must be obtained by the use of duct lining. Let us assume that 10 diameters, or 90 in., of a material having a coefficient at 256 cycles of 0.40 have been specified to take care of air rush noise at the outlet. Referring again to Fig. 3 we find that this will provide 1.5 db. per ft. in the 8 by 10 in. duct, or more than 11 db. The level of the blower noise will accordingly be reduced to about 43 db., which is two decibels below the anticipated level and hence should be considered satisfactory.

If instead of an office, this had been an apartment, where the anticipated level is about 37 db., it would have been necessary to treat an additional length of duct with lining material to bring the level down to that normal to the room. In this case, the additional treatment is probably best located in the main supply duct leading from the fan, since treatment located at this point will have an effect in all rooms. According to the graph this would have required approximately ten feet of duct lining at 0.84 db. per ft. or a total of 40 sq. ft. of treatment. Installed in the smaller duct, a treated length of 5 ft. 4 in., or 16 sq. ft. would have been adequate. However, if there are three or more such outlets to be considered, treatment in the main duct is more economical.

Free Steam for Italy

ITALY, although possessing considerable water power, is very poor in fuel supply, according to a recent issue of Archiv fur Warmewirtschaft und Dampfkesselwesen. Her desire to be independent of the importation of foreign fuels for power generation has led to renewed interest in the natural steam seams that underlie the district of Toscana and the high valleys of Cecina and Cornia, embracing an area of about 75 sq. mi. The steam supply from these seams is constant and the pressure uniform, ranging from 64 to 71 lb. per sq. in. in different sections, depending upon the depth of the drillings. It has entrained about 5% carbonic acid and minor percentages of other substances, including boric acid.

The first application to power generation dates back to 1904 when the steam was put through a small reciprocating engine to provide electricity for a few lamps. A year later a larger engine of about 40 hp. was installed and remained in service for 15 years. A small central station containing a 250-kw. condensing turbine-generator was erected in 1912.

Three 3000-kw. Parsons turbines using the natural steam direct after it had passed through apparatus for removing the condensible gases were later installed.

A still later installation of 750-kw. turbines uses the natural steam directly without extracting the gases and the exhaust is led to chemical equipment for the recovery of boric acid, carbonic acid, ammonia and other rarer constituents such as argon, neon and helium. The exhaust still has sufficient heat to serve as the heating medium for the extraction process. In this case the relatively low thermodynamic use of the turbine is offset by the simplicity and low cost of the installation. Moreover, the cost of steam is nil.

Earlier drillings to a depth of 500 ft. yielded quantities of steam up to 66,000 lb. per hr., whereas recent drillings to greater depth, and of larger diameter have yielded 440,000 lb. of steam at 71 lb. pressure, 400F per hr. per well. The total present output of the district is 2,650,000 lb. per hr.

The generating capacity now installed is 66,000 kw. which produces about 500 million kilowatt-hours annually. It is estimated that approximately a tenth of the present total energy requirements of Italy could be provided by ground steam available in the Toscana district.

Data on Heat Output of Poultry Result from Government Research

By H. G. BAROTT†

In order to obtain best results from domestic animals and fowls, proper air conditions are necessary. However, to maintain given air conditions a knowledge of the heat output of the animals or fowls is necessary. The author of this article describes how the heat production of poultry is determined as well as the air conditioning plant used in connection with the tests.

THE body temperature of all warm blooded animals, including birds, must be maintained within narrow limits for survival, regardless of wide variations in the production of heat and in the environmental conditions. In order to accomplish this, there must be an exact balance between the production of heat within the body and the loss of heat from the body.

The amount of energy produced as heat in metabolism* is definitely related to the amount of oxygen used and the amount of carbon dioxide and water vapor eliminated in the respiratory processes.

Therefore, in the maintenance of body temperature there is always a definite relationship between the heat, carbon dioxide and water elimination and oxygen consumption on one side and environmental conditions and kind and quantity of food which is being metabolized on the other.

A study of the inter-relationship of all these factors is of great value not only from the biological standpoint, which has to do with the supply of food in the proper proportions of carbohydrate, fat and protein, but also from the physical standpoint which has to do with proper clothing, housing, and air conditioning.

The Animal Nutrition Division of the Bureau of Animal Industry maintains a respiration calorimeter laboratory (Fig. 1) at the Agricultural Research Center, Beltsville, Md. This laboratory is equipped with apparatus designed and constructed to determine the magnitude of the metabolic processes by measuring the heat elimination and gaseous exchange and thus to determine the effect on these factors of environmental conditions and the feeding of different foodstuffs.

The respiration calorimeter, in the form used in this laboratory, is an instrument of precision, the principles of which may be summed up as follows: for the determination of gaseous exchange the device is a gas-tight chamber connected to a system of gas absorbers in a closed circuit. The gas confined in the system is kept in circulation, the gaseous products imparted to it by the experimental material are constantly removed and oxygen constantly supplied to replace that consumed. For the measurement of heat produced in the chamber, the device is a constant-temperature, continuous waterflow calorimeter, in which provision is made for preventing the loss or gain of heat through the walls of the chamber or in the circulating gas, and for taking up the heat by a current of water as fast as it is generated in the chamber. The determination of gaseous exchange and heat elimination, to be of value, demands a high degree of accuracy in the fundamental measurements, and it follows that the instruments with which they are made must be precise and finally adjusted. The calorimeter must be large enough for the purpose of the experiment and yet not so large that its volume will prevent the accurate measurement of the various factors involved.

This type of apparatus is adaptable for use with animals (including man), birds, fruits, and vegetables, as each one of these exhibits the same type of reactions relative to heat elimination and gaseous exchange. Growing plants consume carbon dioxide and eliminate oxygen especially in the sunlight; therefore, in a study of plant life the procedure would be altered to some extent. Otherwise, all that is necessary is to adapt the size of the chamber to the material under observation.

At the present time the calorimeter is being used for studying the effects of environmental conditions on poultry and determining the reactions of poultry to various types of feeding stuffs.

The atmosphere of the empty chamber contains oxygen, nitrogen, carbon dioxide and water vapor in the same proportion as in the surrounding air. This proportion begins to change when the birds are placed therein, because they consume oxygen and eliminate water vapor and carbon dioxide. The removal of this

Fig. 1. Respiration calorimeters and accessory apparatus: (1) Calorimeters; (2) oxygen meters; (3) absorption trains; (4) water tank and balance; (5) parts of galvanometer system; (6) recorders; (7) control rheostats; (8) automatic controllers; (9) Wheatstone bridge; (10) potentiometer; (11) Crowell blower.

†Animal Nutrition Division, Bureau of Animal Industry, U. S. Department of Agriculture.

*Metabolism is the sum of the changes going on continuously in living cells by which energy is provided for the vital processes and activities and new material is assimilated to repair the waste.

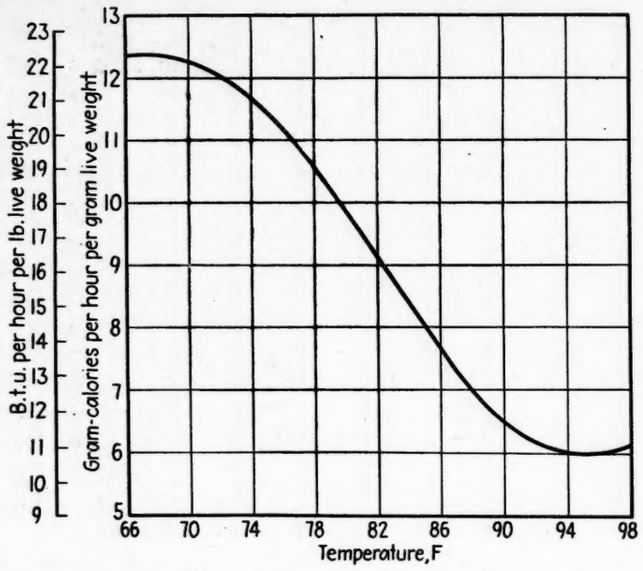


Fig. 2. Heat elimination for normal chicks one to four days old.

carbon dioxide and water vapor and the restoration of the oxygen used, in such a manner that the quantity can be measured accurately, form the basis of the determination of the gaseous exchange. The carbon dioxide and water vapor imparted to the air are removed by passing the air through specially designed absorbers. The increase in weight of these absorbers during a given time interval shows the amount of these products carried out of the chamber during this period. In a system of this type, as fast as any gas is removed from the air, other gas is introduced to maintain atmospheric pressure in the chamber. Oxygen is supplied in this case. The quantity added is accurately metered for the period covering the measurements.

The quantity of water vapor, carbon dioxide and oxygen measured corrected for any small change in the composition of the air in the system determines the total gaseous exchange of the experimental material.

Heat is removed from the calorimeter in two ways: as latent heat of water vapor in the circulating air and as sensible heat liberated to the air by conduction and radiation from the birds.

The quantity of heat leaving the chamber as latent heat of water vapor in any given period is determined by multiplying the weight of the water removed in the absorption flasks by the latent heat of vaporization.

The energy eliminated as sensible heat is absorbed in a stream of water which circulates through a heat absorber coil within the chamber. The weight of the water that flows through the coil in a given period, multiplied by the difference in temperature of the water as it enters and leaves the chamber, represents the amount of heat removed during the period.

The sum of the latent and sensible heat is equal to the total heat elimination from the birds.

The effect of environmental conditions and of feed on poultry (and this is also true for all animals, including man), can be shown by two very striking illustrations of the results from this laboratory's researches.

Normal chicks, one to four days old, were exposed to various degrees of temperature, ranging from 66F to 98F. All other factors, including composition of the air, humidity, etc., were the same for all temperatures. The curve (Fig. 2) constructed from data obtained in these researches shows the enormous increase in heat output as the temperature drops from 96 to 68F.

This increase is due to the increased metabolism necessary to maintain body temperature. It is seen that the heat output at 68F is more than twice that at 96F. A minimum of nutritional material must be metabolized to supply sufficient energy to maintain normal functions when activity is reduced as far as possible. This minimum metabolism is termed the basal metabolism. Energy expenditure for accomplishment of work, for the digestive processes after ingestion of food, for temperature adjustment or for any other environmental factor which calls for a metabolic change, must be added to the basal metabolism to obtain the total metabolism.

Curve 1, Fig. 3, shows the effect of fasting on heat elimination. The heat elimination falls so rapidly during the first day after feed is removed that at the end of the first 24 hours of fast it is less than 82% of that at the beginning. On the second day of the fast it falls approximately one-half as much as on the first day, and by the end of the third day the metabolic rate is approximately 70% of that at the beginning of the fast. It remains practically constant at this level (basal) for several more days.

A very interesting phenomenon relative to the metabolism of poultry can be noted from the curve, namely, a diurnal rhythm. The metabolic rate is highest at 8 a.m. and gradually falls until it reaches a minimum at 8 p.m., then rises again to another maximum at 8 a.m. The course of this rhythm was proved for the first time by these experiments.

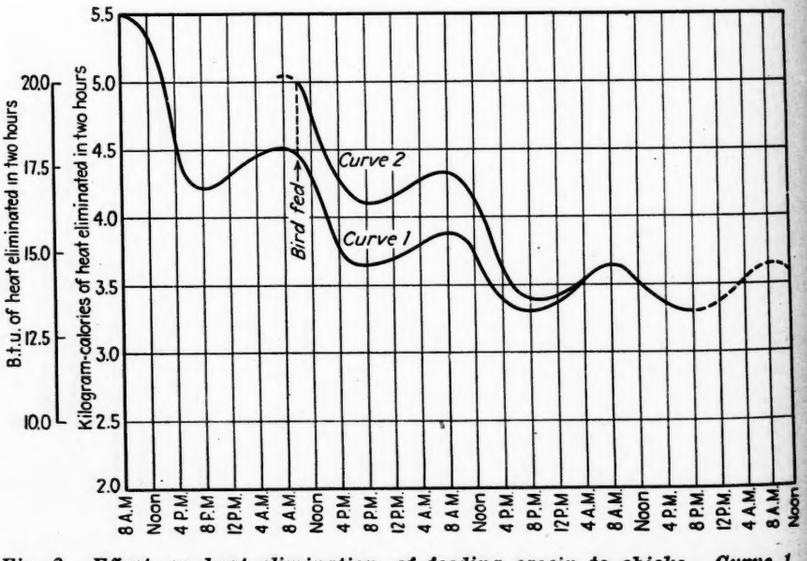


Fig. 3. Effect, on heat elimination, of feeding casein to chicks. Curve 1 shows normal course of heat elimination during fasting; curve 2 shows effect of feeding casein at beginning of second day of fast. Data are based on 9½-week-old chicks (approximately 720 gram weight) fed 9.25 grams of casein.

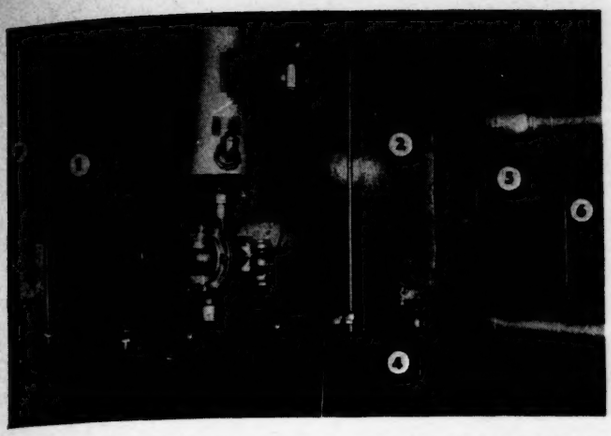


Fig. 4. Air conditioning plant for respiration calorimeter laboratory. (1) Location of air filter; (2) spray chamber; (4) sump tank to collect water from spray nozzles; (5) location of cooling unit; (6) centrifugal blower for air circulation; (7) fresh air duct.

The very pronounced effect of feeding a protein (casein) is illustrated by the abrupt rise in the heat elimination immediately after such protein ingestion. It must be understood that whereas fat may be used for energy or stored as fat in the body, and that carbohydrate may be used for energy or transformed to fat in the body and stored as such, proteins are used chiefly for the production and replacement of tissue. Only a portion of the surplus may be transformed and stored while the larger portion must be eliminated from the body. This metabolism of protein is accompanied by a high heat production.

In certain experiments one gram of casein per kilogram of live weight of fowl was fed at the beginning of the second day of the fast. The heat output after this feeding rose abruptly to 113.5% of its previous value, the increase being due solely to the protein ingested. Curve 2, Fig. 3, shows the course of metabolism after the ingestion of this protein. It is seen that the metabolic rate remains greater than it was when no feed was given for approximately two days, at which time it reaches the same basal value as when no feed was given (Curve 1). When the birds are again put on full feed the metabolic rate returns to the value at the beginning of the fast.

These examples show the importance of proper feed and proper environmental conditions. The importance of air conditioning has recently become more fully realized and vast strides have been made in such apparatus and methods. It is important that the conditions in the laboratory here described relative to temperature, humidity, freedom from dust and composition of the air should be carefully controlled. To do this a small conditioning apparatus was designed and installed (Fig. 4). This apparatus is simple and efficient. It is a complete air conditioning plant for heating and cooling, humidification and dehumidification, as well as removal of dust and germs. A copper chamber 5 ft. long contains a dry filter, a spray chamber, a cooling unit and a heating unit.

The air leaves the laboratory through a wall grill to an 8-in. round duct leading to a dry filter unit (1). The filter is a special glass mat in sheets with only 0.03-in. pressure drop and the dust-holding capacity is large. From the filter the air passes to a spray chamber (2) equipped with two spray nozzles which are supplied with water by the centrifugal pumping unit (3). Distilled water is used and is treated with benzyl-phenol in solution. The water from the spray nozzles collects in the copper tank (4), which is fitted with a float valve which admits water as needed from the still. The pumping unit pumps from this tank and is controlled both by the automatic control on the pressure tank and from a humidistat in the calorimetric laboratory. The automatic pressure control keeps the pressure between 20 and 40 lb., which is ample to operate the nozzles satisfactorily. When the humidistat is at "off" the pump will not run regardless of drop in pressure, but as soon as the humidity drops below the setting of the humidistat, this instrument completes the electric circuit to the pump motor and starts the pump.

The benzyl-phenol keeps the germ content of the water low and kills many of the bacteria in the air.

From the spray chamber the circulating air passes a series of baffle plates to remove any droplets of water which are carried along by the air. It then passes a heat interchanger unit (5) through which brine from the refrigerating unit is passed. The coil has many small passages so the air is brought into intimate contact with the cooling unit. From the cooling unit it passes an electric heater, then through the centrifugal blower (6) to the laboratory. The blower is operated by a 1,750 r.p.m. motor and moves 1,100 c.f.m.

The temperature control of the laboratory is by either of two thermostats. One thermostat operates a solenoid valve on the brine line, which in turn controls the flow of cold brine to the cooling unit (5). The other thermostat controls the electric energy to the heating coil. The choice of control thermostat depends upon the environmental conditions. If the conditions are such that cooling is necessary the brine cooling system is used. When the temperature in the laboratory rises slightly the thermostat closes, energizing the coil of the solenoid valve which opens and allows the cold brine to flow through the cooling unit. This continues until the proper temperature is reached in the laboratory, then the thermostat opens and breaks the electric circuit which closes the valve and no further cooling takes place until a rise in temperature again closes the circuit through the thermostat. When it is necessary to use the heater for temperature control, the thermostat closes at a small drop in temperature and the heater is energized. Heat is added to the air until the proper temperature is reached in the laboratory.

One condition may arise that calls for simultaneous operation of both cooling and heating. The dehumidification is accomplished by condensation of the water vapor on the cooling coil. Therefore, if at any time, to accomplish dehumidification, the coil must be operated at a temperature so low that the air would enter the laboratory at too low a temperature, then the heater must also be used. With such a condition the cooling coil would be in continuous operation and the temperature control would be by the thermostat controlling the heater.

A fresh air duct (7) is connected from outside of the building to the housing for the filter so all air enters through this filter. The amount of fresh air admitted is controlled by a valve in the fresh air duct.

Practical Heating Experience with Income Properties

"WHAT we want to know is the yearly cost of heating these buildings in dollars and cents." This was the simple instruction of the owners of several large buildings in New York City when they placed their heating problem in the hands of combustion engineers about five years ago. How this assignment was handled and the results obtained is the basis of this article.

The first requirement was that all heating plants should be placed in first-class condition. The next was

MONTHLY FUEL REPORT Month of_____ 19__

Address_____

Total Apts._____ Total Rooms_____ Total Baths_____ Vacancies_____

Kind of Fuel Used_____ Price_____

Date	Temperature	Amount Coal or Oil Used, (Heating)	Amount Coal or Oil Used, (Hot Water)	Ashes, Lb.	Coal or Oil Deliveries
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
Total					
Amt. on Hand					

Remarks

Instructions: Daily record of fuel consumption is to be accurately kept by superintendent and turned into the office on the first of each month. Outside temperature to be taken and recorded at 7 a.m. This record must be kept up to date at all times.

Fig. 1

that this be done at minimum cost. And, finally, that fuel expense be brought to the lowest practical amount.

Fuel Records

The initial step in carrying out the program was the setting up of a fuel recording system for each building. Records already at hand were generally casual and inaccurate. In most cases, no monthly totals had been kept. It was, therefore, necessary to establish a routine whereby all fuel used was carefully weighed each day and recorded on a standard chart. It was also desirable that a daily record of ashes be kept together with other pertinent data, such as outdoor temperatures and unusual demands for heat. Such a system was immediately started and closely supervised. As soon as the monthly totals were available, they even checked against fuel on hand at the start and at the end of the period with additions to the supply caused by deliveries. In this way very accurate figures on consumption were assured. Fig. 1 is a form of the fuel recording chart used for monthly results.

It is interesting to note here that the foregoing simple procedure soon began to show economies. Boiler room attendants became "fuel conscious." The fact that operations were recorded and watched brought consumption down 5% and more in most cases without stinting the buildings of necessary heat. Furthermore, each fireman took an increased interest and pride in his record and strove for improvement.

Building Classification

It was soon found that fairly comparable results of the various buildings were feasible only where the structures had certain similar physical characteristics. It was obvious that the results obtained in an apartment house of 1000 rooms were not comparable to one having 500 rooms. Or that a house having 7- or 8-room suites be rated with one having 2-, 3-, or 4-room suites. Thus a series of classifications was established which grouped together buildings having (1) Comparable occupancies; (2) Approximately the same cubic contents and construction; (3) Approximately the same exposures; (4) Heating plants using the same type of fuel.

Comparison of Efficiency

An average performance figure was obtained each month for each group or class of buildings by the use of an index of performance for each structure. This index was the average daily consumption expressed in pounds of fuel per 1000 cu. ft. of heated space. The average of any group for the month was taken as a yardstick of plant efficiency. Buildings which exceeded this average were investigated closely to determine wherein they failed to keep within the average. Also, those showing exceptional results were studied for use as models for those with poor records.

Fig. 2 shows this method of analyzing monthly indices for one group designated Class (3).

From Fig. 2 it will be noted that four buildings—360 High Street, 561 Radnor Avenue, 469 Monroe Street, and 50 South Ward Avenue—had performance figures showing fuel consumption exceeding the average for the 10 buildings of 4.41 for the month. With this information available attention was focused on these

CLASS 3. (CUBIC CONTENTS 500,000 TO 700,000)

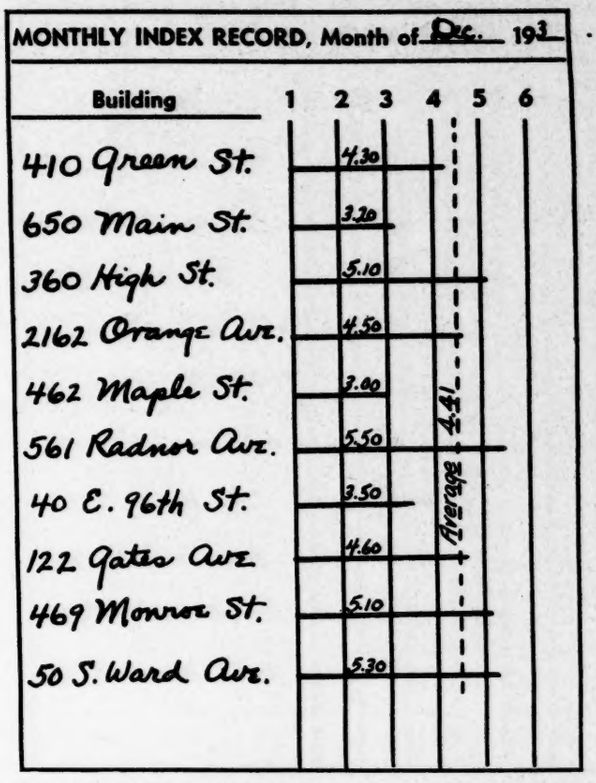


Fig. 2. Monthly fuel indexes in pounds of coal per day per thousand cubic feet of heated space in building.

four cases and it developed that:

360 High Street had defective draft control, 561 Radnor Avenue was inefficiently fired, 469 Monroe Street had a poorly arranged hot water system, 50 South Ward Avenue had many air leaks in the boiler setting.

With the causes for poor results found and corrected, the performances of these four buildings greatly improved in subsequent records.

It will be noted that in charting the performances for efficiency, no account was taken of outdoor temperatures. This factor was weighed only where exceptional exposures occurred, since all buildings were in substantially the same district and subject to substantially the same outdoor temperatures.

When the results for the first year were available, the engineers in charge had a mass of unusually valuable data on heating. While most of the records were better than average, there were many which showed excellent savings. These good cases were set up as examples for the next year. It is interesting to note that in many instances these buildings which had been deficient in the first year were brought up to average the next season. Carefully tabulated results for the second year showed an overall saving of 10% and more above the first year.

Generally speaking, no experimentation was undertaken in the operation of these heating plants. The practices employed, as well as the types of equipment used, were only those recognized for years as sound among experienced combustion engineers. In all cases the results were measured in dollars and cents, this being the expressed intention of the entire program. The data compiled after five years of operation now form an unusual record for future reference.

Pressure Drop in Refrigerant Suction Lines

By E. GYGAX,† KARL S. WILLSON‡ and GEORGE H. CLARK‡

A knowledge of the pressure drop to be expected in refrigerant suction lines is of considerable importance to all engineers dealing with the design and installation of air conditioning and refrigeration systems. Excessive pressure drops not only result in reduced capacity but also will increase considerably the operating cost. Up to this time practically all of the data available have been theoretical and very little work has been done on actually measuring the pressure drops. For that reason engineers will be interested in this article which gives experimental data on the pressure drops in copper lines carrying methyl chloride and dichlorodifluoromethane. This material has been abstracted from a recent article in The Refrigeration Service Engineer

ALTHOUGH knowledge of the pressure drop to be expected in suction lines has long been recognized as essential in correctly designing refrigeration and air conditioning installations, complete experimental data have been lacking or their use buried in a maze of complicated calculations.

In the belief that actual experimental determination of the pressure drops in various sizes of pipes under various conditions would be valuable, the work reported on was undertaken. The data have since been found to check quite accurately with a general formula for fluid flow.

The test apparatus consisted of various sized (½ to 20 hp.) compressors, an electric calorimeter which acted as evaporator and superheater, and the test pipe to which suitable gages were attached at each end in order to measure the pressure drop. The calorimeter served to measure the operating capacity under the given conditions. The feed liquid entered the calorimeter at 90F (room temperature) and the gas was superheated to 65F. The temperature of evaporation was maintained at 0F, 20F and 40F in various tests. Although slight variations in liquid and suction gas temperatures occurred, these variations were held to a minimum and, as will be shown later, do not seriously affect the results obtained. Copper tubes formed into coils free from sharp bends and dents were used.

Tests were made using Freon and methyl chloride evaporating at 0F, 20F, and 40F, and the results plotted on graphs to show the increase in pressure drop with increasing refrigerating capacities for tube dimensions from ½ to 1⅝ in. inside diameter. Following this, calculations were made for the pressure drop to be expected and these figures were plotted on the same graph and the results compared. In most cases the agreement between the experimental and calculated values were found to be satisfactory. Slight differences were believed to be the result of oil on the walls of the tubes, variations in test conditions, and slide rule errors.

When the experimental and calculated data were found to check satisfactorily, it occurred to the authors that the pressure drop information might be extended, modified, and listed in the tabular form as shown in

†Curtis Refrigerating Machine Co., St. Louis, Mo.
‡Ansul Chemical Co., Marinette, Wis.

PRESSURE DROP IN REFRIGERANT SUCTION LINES CARRYING 3,000 TO 36,000 B.T.U. PER HR.
(80F LIQUID TO VALVE, 60F GAS IN LINES)

Actual Inside Tube Diameter, In.	Evaporator Temp., F	Refrigeration Load, B.T.U. Per Hr.														
		3,000			6,000			12,000			24,000			36,000		
		Refrigerant—Methyl Chloride, Sulphur Dioxide, Freon														
		M	S	F	M	S	F	M	S	F	M	S	F	M	S	F
		Pressure Drop—Lb. Per Sq. In. Per 100 Ft.														
5/16	40	2.4	3.7	4.7	7.7	12.3	17.1									
	20	3.7	5.9	7.2												
	0	5.9	10.0	12.7												
	— 20	10.6	18.1	21.1												
7/16	40	.4	.7	.9	1.5	2.4	3.5	5.2	8.3	12.2						
	20	.7	1.2	1.4	2.3	3.8	5.4									
	0	1.1	1.9	2.4	3.8	6.5	9.4									
	— 20	1.9	3.5	4.0	6.4	11.7	15.7									
9/16	40	.1	.2	.3	.5	.8	1.0	1.6	2.5	3.6	5.6	9.0	12.2	11.5	18.1	25.8
	20	.2	.4	.5	.8	1.2	1.6	2.5	4.0	5.5						
	0	.4	.6	.8	1.2	2.0	2.8	4.0	6.8	9.7						
	— 20	.6	1.1	2.1	2.1	3.2	4.7	6.8	12.2	16.1						
3/4	40	.0	.1	.1	.1	.2	.5	.4	.6	.9	1.4	2.2	3.1	2.9	4.5	6.2
	20	.1	.1	.1	.2	.3	.7	.6	1.0	1.4	2.2	3.5	4.8	4.5	7.2	9.5
	0	.1	.2	.2	.3	.5	1.3	1.0	1.7	2.4	3.5	5.9	8.4	7.3	12.2	16.7
	— 20	.2	.3	.3	.5	.9	2.1	1.8	3.0	4.0	6.0	10.7	13.9	12.4	22.0	27.8
1	40						.1	.1	.2	.2	.4	.5	.8	.7	1.1	1.6
	20						.1	.2	.3	.4	.6	.9	1.2	1.2	1.8	2.5
	0						.2	.3	.4	.6	.9	1.5	2.2	1.8	3.1	4.4
	— 20						.3	.4	.8	1.0	1.5	2.6	3.6	3.1	5.6	7.3
1 1/2	40										.1	.1	.1	.1	.2	.2
	20										.1	.1	.2	.2	.3	.4
	0										.1	.2	.3	.3	.4	.7
	— 20										.2	.4	.5	.5	.8	1.1

the tables. It should be noted that the values given are for actual inside diameters rather than for pipe sizes. The data are of course given for drawn copper pipe or its equivalent.

The values for methyl chloride and Freon have been carried to higher temperatures and larger pipe sizes than were used experimentally and are thus unverified in these regions.

It was believed that pressure drop in SO_2 suction lines should be capable of similar calculation by this method. Values for SO_2 have been so obtained which are reasonable and are included, although no experimental work has been done to verify the calculated values.

Since variation in the evaporation temperature affects mainly the volume of the refrigerant, multiplying factors may be used with satisfactory practical accuracy for calculating the pressure drop at other temperatures when the pressure drop for 40F is known. Thus, for a given pipe and tonnage the pressure drop may be determined quite accurately for 20F evaporation by multiplying the pressure drop as calculated for 40F evaporation by 1.60 for SO_2, 1.56 for methyl chloride, or 1.54 for Freon. For 0F evaporation, the factors are 2.70, 2.51, and 2.70, and for –20F evaporation, 4.88, 4.28, and 4.48 for SO_2, methyl chloride, and Freon, respectively.

The effects of change in liquid temperature and suction gas temperature are smaller than those due to changes in evaporation temperatures and the pressure drop under various conditions may be determined with reasonable accuracy from the values given in the table by means of the following corrections:

For 10F increase in liquid temperature, the pressure drop is about 5% greater for sulphur dioxide and methyl chloride and 10% greater for Freon.

For 10F increase in the temperature of the superheated suction gas, the pressure drop is about 2% greater for the three refrigerants.

It should be noted that in the tables, values are calculated on the assumption that saturated gas leaves the evaporator. If the gas superheats in the evaporator, added refrigeration equivalent to the superheat will be secured, in which case the pressure drop will be slightly less than the values given. This variation will in general be of the order of only a per cent or two—of little value in determining the pipe size. It may be taken into account if desired by using the heat content of the gas at the given superheated condition in calculating the effective refrigeration per pound.

It is also to be noted that values in the tables are based on a constant temperature of 60F in the suction line. In the actual installation having no heat interchanger, gas leaving the evaporator in a saturated or slightly superheated condition will warm up in the suction line. The cold gas entering the suction line will have a smaller volume, and hence the pressure drop in the line will be less than for the case where the gas is at a temperature of 60F throughout the pipe.

Since the volume of the gas will be very nearly in the ratio of the absolute temperatures, gas having a pressure drop of 1 lb. with 60F gas would have a drop of only about 0.9 lb. for 10F gas, provided the gas remained at 10F throughout the suction line. Since the gas will ordinarily rise in temperature in the suction line and the superheating occur over varying proportions of the suction line, the effect is not large, probably not over 5%, and it is believed that this factor may well be omitted in most cases and the higher value used to give a slight margin of safety.

PRESSURE DROP IN REFRIGERANT SUCTION LINES CARRYING 60,000 TO 360,000 B.T.U. PER HR.
(80F LIQUID TO VALVE, 60F GAS IN LINES)

Actual Inside Tube Diameter, In.	Evaporator Temp., F	Refrigeration Load, B.T.U. Per Hr.														
		60,000			120,000			180,000			240,000			360,000		
		Refrigerant—Methyl Chloride, Sulphur Dioxide, Freon														
		M	S	F	M	S	F	M	S	F	M	S	F	M	S	F
		Pressure Drop—Lb. Per Sq. In. Per 100 Ft.														
3/4	40	7.4	11.3	15.9												
	20	11.5	18.1													
	0	18.6														
	— 20															
1	40	1.8	2.8	4.3	6.3	9.9	14.1	13.1	20.2	29.1	21.9	32.9	47.4			
	20	2.8	4.5	6.6												
	0	4.5	7.6	11.6												
	— 20	7.7	14.1	19.3												
1 1/2	40	.3	.4	.6	.9	1.4	2.0	1.9	2.9	4.1	3.2	4.9	6.2	6.5	10.0	14.6
	20	.4	.6	.9	1.4	2.2	3.1	2.9	4.6	6.2	5.0	7.8	9.5	10.2	16.0	
	0	.7	1.1	1.5	2.3	3.8	5.4	4.8	7.9	11.0	8.0	13.2	16.7	16.3		
	— 20	1.1	1.9	2.6	3.9	6.8	8.9	8.1	14.2	18.2	13.7	24.0	27.8			
2	40	.1	.1	.2	.2	.4	.5	.5	.7	1.0	.7	1.4	1.8	1.7	2.5	3.8
	20	.1	.2	.2	.4	.6	.8	.7	1.2	1.6	1.1	2.2	2.8	2.6	4.1	5.8
	0	.2	.3	.4	.6	1.0	1.4	1.2	2.0	2.8	1.	3.8	4.9	4.1	6.9	10.2
	— 20	.3	.5	.7	1.0	1.8	2.3	2.0	3.6	4.6	3.1	6.8	8.2	7.1	12.4	16.8
2 1/2	40			.1	.1	.1	.2	.2	.3	.4	.3	.4	.6	.6	.9	1.3
	20			.1	.1	.2	.3	.3	.4	.6	.4	.7	.9	.9	1.4	2.0
	0			.1	.2	.3	.5	.4	.7	1.0	.7	1.1	1.6	1.5	2.3	3.4
	— 20			.2	.3	.6	.8	.7	1.2	1.6	1.2	2.1	2.7	2.5	4.2	5.7
3	40						.1	.1	.1	.2	.1	.2	.3	.2	.4	.5
	20						.1	.1	.2	.2	.2	.3	.4	.4	.6	.8
	0						.2	.2	.3	.4	.3	.5	.7	.6	1.0	1.4
	— 20						.3	.3	.5	.7	.5	.9	1.1	1.0	1.8	2.3
4	40										.0	.0	.1	.1	.1	.1
	20										.1	.1	.1	.1	.1	.2
	0										.1	.1	.2	.2	.2	.4
	— 20										.1	.2	.3	.3	.4	.6

How to Prevent Fire Hazards in Air Conditioning Systems

FIRE hazards in air conditioning and how best to protect against them was discussed by E. W. Fowler, engineer of the National Board of Fire Underwriters, in addressing a general manufacturing group meeting of the 15th annual Eastern Safety Conference, held February 23-24 at the Essex House, Newark, N. J. Following are some abstracts from his address:

An important feature of the fire hazard of air conditioning systems is the possibility it presents for quickly spreading a fire through the building served. This feature of hazard is inherent in the system of ducts through which air is circulated by mechanical draft, and thus is common to all such duct systems, whether used for ventilation, for warm air heating, or for air conditioning.

One way in which fire may thus be spread is for it to be drawn in through the fresh air intake from which point it is spread through the duct system to various portions of the building. Another way is for smoke and hot gases from a fire starting in one room of a building to be carried by way of the return air ducts back to the fan and then to be distributed throughout the building, starting fires in many rooms at once.

Another important feature of fire hazard is the possibility of fire starting in the system and being spread by either the forced or natural draft in the ducts to several floors or to all of the area served. Air filters made of combustible material (including steel wool), the oil used on filters, or heavy accumulations of dust and other combustible material at the filter, have furnished fuel for a number of fires in air conditioning systems.

Several major fires have been caused by combustible linings in ducts, used either for controlling noise or for heat insulation. Combustible coverings used on the outside of ducts and combustible linings in fan rooms have also furnished fuel for fires. Instances were cited where accumulations of combustible dust and waste material in the ducts caused fires which themselves lasted only a short time but which caused heavy smoke damage losses.

In some cases ducts have been made of combustible fireboard and in others air chambers, known as plenum chambers, have been carelessly used for the storage of discarded equipment or as a place for keeping floor mops, cans of oil and such like. The hazard of combustible materials in the system is accentuated by the fact that the draft of air in the system causes materials to burn more rapidly than in quiet air.

One further fire hazard was that which may result from release of refrigerant gases into the air duct system. The hazard which would result from such release of a flammable or toxic gas can readily be imagined.

A simple way by which the hazard of spread of fire and smoke through a building may be effectively reduced, is to install one or more small systems on each floor in place of large systems serving several floors. In this way passage of ducts, and close control of atmospheric conditions in various sections of the building can be more easily obtained. In existing buildings this method may sometimes result in less expensive installations as well as better control of fire and smoke hazards.

Ducts should be constructed of non-combustible material. Linings inside ducts should be as nearly non-combustible as it is possible to obtain. As combustible coverings on the outside are less hazardous than combustible linings inside, heat insulation materials should be applied outside rather than inside.

Automatic fire dampers actuated by fusible links, located at strategic points in duct systems are needed to protect against spread of fire through ducts which serve more than one floor or more than one fire section on a single floor.

Thermostatic controls to automatically shut down fans when air temperatures in the system become excessive as from a fire, are also important.

Care should be exercised in locating the fresh air intake to avoid unnecessary exposure to combustible materials or construction, and where exposures exist suitable automatic protection should be provided.

Regular and frequent cleaning of ducts, filter chambers, and other parts of the system is a vital part of the program for controlling the hazards of air conditioning systems. Suitable access openings should be provided for this purpose.

Air filters should preferably be of a type that will not burn freely or emit large volume of smoke or other objectionable products of combustion when attacked by flame. Underwriters' Laboratories, Inc., a testing organization sponsored by the National Board of Fire Underwriters, has recently developed a testing program for air filters and several types of filters which meet this specification are now listed by the Laboratories. Where filters are not of such a character some form of special automatic fire protection may be needed.

Precautions and safeguards recommended for protection against fire hazards are the principal methods at present available for protection against the smoke hazard, although efforts are being made to develop controls operated by smoke detection. One or two experimental smoke detectors have been installed and research is being conducted to determine the practicableness of such control methods.

Number of Hours per Year of High Dry Bulb Temperatures

In summer air conditioning work, both in connection with design data and operating data, it is helpful to know not only the extreme high temperature experienced in a locality but also the frequency of occurrence of lower but still relatively high temperatures.

What the Tables Are

The accompanying data are intended to fulfill this need. They show, for 41 cities, the count of the number of hours per year the dry bulb temperature exceeded 85, 90, 95, 100, 105, 110, and 115F. These counts are arranged in three ways: Table 1 gives the maximum count

TABLE 1—MAXIMUM NUMBER OF HOURS IN A YEAR DRY BULB TEMPERATURE EXCEEDS CERTAIN TEMPERATURES†

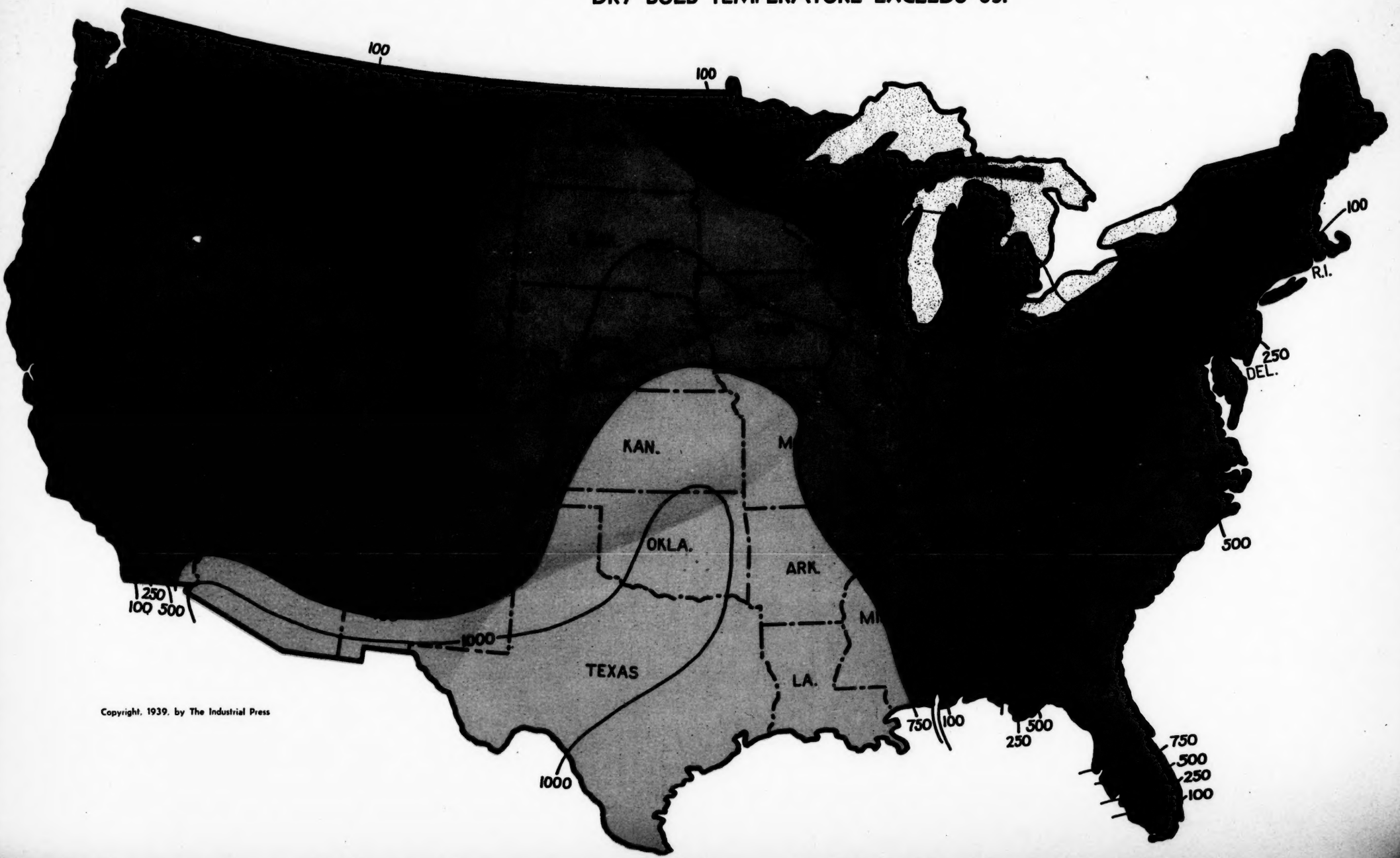
(Based on Weather Bureau records covering 1932-37, incl.)

City	Number of Hours Temperature Exceeds					
	85F	90F	95F	100F	105F	110F
Amarillo, Tex.	950	564	236	23	0	0
Baltimore, Md.	471	162	36	13	2	0
Birmingham, Ala.	773	306	76	10	0	0
Bismarck, N. D.	585	320	179	84	27	6
Boston, Mass.	151	70	20	0	0	0
Buffalo, N. Y.	44	8	2	0	0	0
Chicago, Ill.	306	138	41	13	0	0
Cincinnati, Ohio	675	282	110	43	11	0
Cleveland, Ohio	163	52	9	0	0	0
Columbus, Ohio	564	218	86	26	1	0
Dallas, Tex.	1378	760	269	40	9	0
Denver, Colo.	402	162	28	0	0	0
Des Moines, Ia.	778	450	267	111	34	0
Detroit, Mich.	318	134	61	19	0	0
Duluth, Minn.	152	73	38	11	1	0
El Paso, Tex.	1317	652	240	40	0	0
Fort Wayne, Ind.	472	194	81	29	2	0
Grand Rapids, Mich.	330	130	71	18	2	0
Houston, Tex.	927	319	69	5	0	0
Indianapolis, Ind.	689	310	139	36	1	0
Kansas City, Mo.	1352	824	536	275	105	2
Memphis, Tenn.	932	376	102	20	0	0
Milwaukee, Wis.	204	83	21	8	0	0
Minneapolis, Minn.	419	209	99	53	8	0
New Orleans, La.	923	214	27	0	0	0
New York, N. Y.	139	37	14	0	0	0
Oklahoma City, Okla.	1318	867	501	176	49	6
Omaha, Neb.	908	537	319	141	43	5
Philadelphia, Pa.	328	84	22	11	0	0
Pittsburgh, Pa.	298	77	25	2	0	0
Portland, Oreg.	141	65	24	4	0	0
Richmond, Va.	522	179	48	8	0	0
St. Louis, Mo.	1106	618	336	106	23	0
Salt Lake City, Utah	634	279	75	3	0	0
San Diego, Calif.	6	1	0	0	0	0
San Francisco, Calif.	21	4	2	0	0	0
Savannah, Ga.	777	262	54	0	0	0
Toledo, Ohio	344	153	67	10	0	0
Topeka, Kan.	1227	848	565	320	112	6
Washington, D. C.	405	138	28	8	0	0
Wichita, Kan.	1297	878	530	258	91	11

†There were no hours above 115F in any of the above cities.

Text continues following Map.

AVERAGE NUMBER OF HOURS IN A YEAR
DRY BULB TEMPERATURE EXCEEDS 85F



Copyright, 1939, by The Industrial Press

TABLE 2—AVERAGE NUMBER OF HOURS IN A YEAR DRY BULB TEMPERATURE EXCEEDS CERTAIN TEMPERATURES†

(Based on Weather Bureau records covering 1932-37, incl.)

City	Number of Hours Temperature Exceeds					
	85F	90F	95F	100F	105F	110F
Amarillo, Tex.	749	374	127	12	0	0
Baltimore, Md.	390	121	20	2	1	0
Birmingham, Ala.	645	222	42	4	0	0
Bismarck, N. D.	333	155	65	20	5	1
Boston, Mass.	100	31	5	0	0	0
Buffalo, N. Y.	23	4	1	0	0	0
Chicago, Ill.	226	76	17	3	0	0
Cincinnati, Ohio	424	150	43	14	2	0
Cleveland, Ohio	106	23	3	0	0	0
Columbus, Ohio	349	110	30	8	1	0
Dallas, Tex.	1084	513	149	16	2	0
Denver, Colo.	315	99	9	0	0	0
Des Moines, Ia.	542	263	105	38	11	0
Detroit, Mich.	219	73	19	5	0	0
Duluth, Minn.	54	18	8	2	1	0
El Paso, Tex.	1051	514	158	22	0	0
Fort Wayne, Ind.	306	106	32	10	1	0
Grand Rapids, Mich.	246	74	21	4	1	0
Houston, Tex.	854	282	36	1	0	0
Indianapolis, Ind.	421	148	45	11	1	0
Kansas City, Mo.	892	492	248	101	32	1
Memphis, Tenn.	709	224	37	5	0	0
Milwaukee, Wis.	153	55	11	2	0	0
Minneapolis, Minn.	339	136	42	14	2	0
New Orleans, La.	789	172	13	0	0	0
New York, N. Y.	101	23	3	0	0	0
Oklahoma City, Okla.	996	549	228	46	9	1
Omaha, Neb.	649	349	176	71	22	3
Philadelphia, Pa.	263	59	10	2	0	0
Pittsburgh, Pa.	216	48	7	1	0	0
Portland, Oreg.	82	25	6	1	0	0
Richmond, Va.	431	133	22	2	0	0
St. Louis, Mo.	718	344	124	34	5	0
Salt Lake City, Utah	531	222	47	1	0	0
San Diego, Calif.	3	1	0	0	0	0
San Francisco, Calif.	11	2	1	0	0	0
Savannah, Ga.	669	203	34	0	0	0
Toledo, Ohio	246	85	23	2	0	0
Topeka, Kan.	866	530	292	131	37	2
Washington, D. C.	369	112	16	1	0	0
Wichita, Kan.	918	527	270	102	18	2

†There were no hours above 115F in any of the above cities.

in any year; Table 3 the minimum in any year; and Table 2 the average count per year. All are from an actual hour-by-hour count of the six years from 1932 to 1937, inclusive; consequently, in Table 1 will be found the maximum frequency experienced during that period, and, similarly, Tables 2 and 3 give the average and minimum for that period. Since this period covered a very hot year and a relatively cool year, the data should be reasonably representative of what a long-time count would show.

What the Map is Based On

The map is a plot of the average number of hours above 85F, as shown in tabular form in Table 2, first column. The steep gradient in southern Florida and the peculiar plateau around Pensacola are not from calculated data, but apparently are indicated from other weather data. This is also true of the Rocky Mountain region.

Zones in the Map

The map is so colored as to bring out three major zones; the green zone consists of those regions where there are less than 250 hours in an average year with dry bulb temperatures over 85F; the yellow zone is made up of those regions with over 750 such hours,

while the blue zone is an intermediate one with from 250 to 750 hours over 85F.

Data Cover Day and Night

Note that the data include all hours in the year falling in a given classification, whether those hours occurred in the day or night, or in the spring or fall. Particularly in the hot Middle West and Southwest many of the hot hours occurred at night. Practically all of the hours everywhere occurred in the summer months.

TABLE 3—MINIMUM NUMBER OF HOURS IN A YEAR DRY BULB TEMPERATURE EXCEEDS CERTAIN TEMPERATURES†

(Based on Weather Bureau records covering 1932-37, incl.)

City	Number of Hours Temperature Exceeds					
	85F	90F	95F	100F	105F	110F
Amarillo, Tex.	549	212	42	0	0	0
Baltimore, Md.	294	63	0	0	0	0
Birmingham, Ala.	567	164	27	0	0	0
Bismarck, N. D.	210	77	16	0	0	0
Boston, Mass.	70	7	0	0	0	0
Buffalo, N. Y.	5	0	0	0	0	0
Chicago, Ill.	153	30	0	0	0	0
Cincinnati, Ohio	275	49	0	0	0	0
Cleveland, Ohio	59	4	0	0	0	0
Columbus, Ohio	220	43	0	0	0	0
Dallas, Tex.	802	349	76	0	0	0
Denver, Colo.	231	62	0	0	0	0
Des Moines, Ia.	325	104	21	0	0	0
Detroit, Mich.	131	26	0	0	0	0
Duluth, Minn.	12	0	0	0	0	0
El Paso, Tex.	874	383	81	5	0	0
Fort Wayne, Ind.	166	20	0	0	0	0
Grand Rapids, Mich.	129	24	0	0	0	0
Houston, Tex.	718	218	22	0	0	0
Indianapolis, Ind.	258	37	0	0	0	0
Kansas City, Mo.	520	205	22	0	0	0
Memphis, Tenn.	548	115	4	0	0	0
Milwaukee, Wis.	84	21	1	0	0	0
Minneapolis, Minn.	211	78	11	0	0	0
New Orleans, La.	613	107	0	0	0	0
New York, N. Y.	43	0	0	0	0	0
Oklahoma City, Okla.	754	350	81	3	0	0
Omaha, Neb.	389	160	32	1	0	0
Philadelphia, Pa.	186	25	0	0	0	0
Pittsburgh, Pa.	116	4	0	0	0	0
Portland, Oreg.	56	8	0	0	0	0
Richmond, Va.	279	57	1	0	0	0
St. Louis, Mo.	456	170	12	0	0	0
Salt Lake City, Utah	409	111	4	0	0	0
San Diego, Calif.	1	0	0	0	0	0
San Francisco, Calif.	6	0	0	0	0	0
Savannah, Ga.	585	150	11	0	0	0
Toledo, Ohio	143	32	0	0	0	0
Topeka, Kan.	488	212	32	0	0	0
Washington, D. C.	319	81	7	0	0	0
Wichita, Kan.	667	295	66	2	0	0

†There were no hours above 115F in any of the above cities.

Check List for Air Conditioning Servicing

By JOSEPH F. KERN, Jr.†

SELF-CONTAINED ROOM UNIT—AIR COOLED

COMPLAINT—ROOM TOO WARM

POSSIBLE CAUSE	CHECK	DETAILS	REMEDY
Condensing unit not operating	Electrical connections	Test lead-in wire to see if current is reaching compressor motor. Check fuses	Replace fuses or wiring
	Condensing unit motor	Motor windings may be burned out	Replace motor
		If unit has direct current motor, commutator may be dirty or mica need undercutting	Clean commutator or undercut mica
	Motor overload switch	Motor overload switch may have opened due to: 1. Failure of holding mechanism or dirty contact points 2. Low line voltage 3. Belt driving compressor may be too tight 4. Bearings too tight or lack oil	1. Clean, repair or replace motor overload switch 2. Decrease load on circuit or increase wire size 3. Loosen belt 4. Repair or oil bearings
	Head pressure	Motor overload switch or high pressure cut-out may have been opened because of high head pressure due to: 1. Air in system 2. Excessive refrigerant 3. Dirty condenser 4. Closed window which prevents air flowing to condenser	1. Purge system 2. Release some refrigerant 3. Clean 4. Open window
	Expansion valve	Expansion valve which has lost its charge	Replace expansion valve
Fan not operating	Fan motor	Fan motor may be burned out or wire may be loose. Cooling coil may be found frosted up	Tighten connections or replace motor
Condensing unit not operating at full capacity	Line voltage	If line voltage is low, the motor will not drive compressor at proper speed	Decrease load on circuit or increase size of wires
	Belt driving compressor	If belt is loose it will slip and cause a loss in power and reduced capacity	Tighten belt
	Head pressure	Capacity may be reduced due to high head pressure caused by: 1. A dirty condenser 2. An overcharged system 3. Air in system	1. Clean condenser 2. Release some refrigerant 3. Purge system
	Sweating area of coil	A partially sweating coil may be caused by: 1. Thermal expansion valve bulb being located too close to end of coil 2. Shortage of refrigerant. Listen at expansion valve for a hissing noise 3. A dirty strainer 4. Moisture in system freezing out at expansion valve thus reducing or stopping refrigerant flow. Try warming expansion valve to melt the ice 5. Improper adjustment of expansion valve 6. Expansion valve which has lost some or all of its charge 7. Leaky valves or pistons in compressor	1. Relocate feeler bulb further from coil 2. Add refrigerant 3. Clean strainer in liquid line and expansion valve 4. Install dehydrator in liquid line or replace dehydrator charge if already installed 5. Adjust expansion valve 6. Replace expansion valve 7. Repair or replace compressor
	Air filter	A dirty filter will reduce air flow and cooling capacity. Coil may be found frosted up	Clean or replace filter
	Cooling coil	A frosted cooling coil on a system with a thermal expansion valve may be caused by too low a cut-out pressure setting on pressure control	Raise cut-out pressure
		A frosted cooling coil on a system equipped with an automatic expansion valve may be caused by too low a pressure setting of valve	Raise pressure setting
Inadequate air supply	Window opening	If window is not opened sufficiently or is not of right size, air flow will be restricted and cooling capacity reduced	Increase size of window opening
Short circuiting of air	Baffle between intake and exhaust chambers	If baffle is not air-tight, air may short circuit and hot discharge air get into air supply	Make baffle air-tight
	Dividing strip in window duct	Dividing strip in the window duct should be in position and run to end of duct	Place strip in correct position and extend if necessary
Cooling capacity inadequate	Capacity against heat gain	Check rated capacity against heat load of room	Reduce heat load by shading windows, insulating rooms, turning off appliances or lights. Install larger unit

†*Assistant Editor, HEATING & VENTILATING*

SELF-CONTAINED ROOM UNIT—WATER COOLED

Complaint—Room Too Warm

Possible Cause	Check	Details	Remedy
Condensing unit not operating	Electrical connections	Test lead-in wire. Check fuses	Replace fuses or wiring
	Condensing unit motor	Motor windings may be burned out	Replace motor
		On direct current motor, commutator may be dirty	Clean commutator
	Fan motor	Fan motor may be burned out or wire loose. Unless fan is operating condensing unit will not run	Tighten connections or replace fan motor
	Motor overload switch	Motor overload switch may break motor circuit due to: 1. Failure of holding mechanism 2. Line voltage too low 3. Compressor driving belt too tight 4. Bearings need oil 5. Bearings tight	1. Replace switch 2. Decrease load on circuit or increase wire size 3. Loosen belt 4. Oil bearings 5. Repair bearings
	Head pressure	A high head pressure caused by any of the following may open motor overload switch or high pressure cut-out: 1. Air in system 2. Excessive refrigerant 3. Water supply insufficient 4. Water temperature too high 5. Dirty or clogged condenser	1. Purge system 2. Remove some refrigerant 3. Increase pressure or pipe size 4. Use evaporative condenser or increase water flow 5. Clean condenser
	Expansion valve	A thermal expansion valve which has lost its charge or is badly out of adjustment may shut off supply of refrigerant	Adjust valve or replace
Condensing unit not operating at full capacity	Belt driving compressor	If belt is loose there is loss in power and reduced capacity	Tighten belt
	Head pressure	A high head pressure caused by any of the following may cause a reduced capacity: 1. Air in system 2. Excessive refrigerant 3. Water supply insufficient 4. Water temperature too high 5. Dirty or clogged condenser	1. Purge system 2. Remove some refrigerant 3. Increase pressure or size of pipe 4. Increase rate of water flow or use an evaporative condenser 5. Clean condenser
	Sweating area of coil	A partially sweating coil may be caused by: 1. Thermal expansion valve bulb being located too close to end of coil 2. Shortage of refrigerant. Listen at expansion valve for a hissing noise 3. A dirty strainer, reducing the flow of refrigerant 4. Moisture in system which has frozen out at expansion valve, reducing or stopping the flow. Try warming expansion valve to melt the ice 5. Improper adjustment of thermal expansion valve 6. Thermal expansion valve may have lost its charge 7. Leaky valves or pistons in compressor	1. Relocate feeler bulb further from coil 2. Add refrigerant 3. Clean strainers 4. Install dehydrator in liquid line or replace dehydrator charge 5. Adjust 6. Replace expansion valve 7. Repair compressor
	Frosted cooling coil	A frosted cooling coil may be caused by: 1. A dirty filter 2. Too low a setting on low pressure cut-out	1. Clean or replace filter 2. Raise cut-out pressure
Cooling capacity inadequate	Capacity against heat gain	Check rated capacity against heat load of room	Reduce heat load by shading windows, insulating rooms, turning off appliances. Install larger unit

SELF-CONTAINED ROOM UNITS—AIR COOLED OR WATER COOLED

Complaint—Odors

Possible Cause	Check	Details	Remedy
Dirty condensate pan and coil	Condensate pan and coil surface	Dirt, smoke and oil deposited on coil and pan surface will frequently cause the air to have an odor	Clean pan and coil with a brush and cleaning solution
Loose Belt	Belt	A loose belt may slip sufficiently to burn and cause an odor	Tighten belt
Overheated motor	Motor	Motor may be overheated due to failure of motor overload switch to open and a high head pressure, tight belt or tight bearings. High head pressure may be caused by air in system, too much refrigerant or dirty condenser	Repair or install motor overload switch. Decrease high head pressure by purging, releasing some refrigerant or cleansing condenser. Loosen belt

Complaint—Noise

Fan or blower	Fan blades	A broken propeller fan blade may cause noise	Repair or replace fan
	Wheel	Blades or wheel may strike sides of scroll causing a noise	Center
Spring mountings not operating	Spring mounting	The shipping blocks in unit may not have been removed, preventing springs from operating	Remove blocks
Motor	Motor	On D.C. motors a dirty commutator may cause a noise	Clean commutator

SEMI-CENTRAL SYSTEM—DIRECT EXPANDED REFRIGERANT

Complaint—All Rooms Too Warm

Possible Cause	Check	Details	Remedy
No refrigerant reaching evaporators	Condensing unit	Condensing unit may not be operating due to: 1. No electricity at compressor motor. Test lead-in wire and fuses 2. Motor burned out 3. On d.c. motors commutator may be dirty 4. Motor overload switch open due to: (a) Holding mechanism failed (b) Low line voltage (c) Belt driving compressor too tight (d) Bearings too tight or lack oil 5. Motor overload switch or high pressure cut-out may have opened because of high head pressure caused by: (a) Air in system (b) Excessive refrigerant (c) Water supply to condenser insufficient (d) Water to condenser has too high a temperature (e) Dirty or clogged condenser	1. Repair lead-in wire. Replace fuse 2. Replace motor 3. Clean commutator 4. (a) Repair or replace motor overload switch (b) Decrease load on circuit or increase wire size (c) Loosen belt (d) Repair or oil 5. (a) Purge system (b) Release some refrigerant (c) Increase pressure or pipe size (d) Use an evaporative condenser or increase water flow (e) Clean or replace
Not enough refrigerant reaching evaporator	Condensing unit	A shortage of refrigerant will allow gas to pass into liquid line. Listen at expansion valve for a hissing noise	Add refrigerant
		A high head pressure caused by any of the following may cause a reduced capacity: 1. Air in system 2. Excessive refrigerant 3. Water supply insufficient 4. Water temperature too high 5. Dirty or clogged condenser	1. Purge system 2. Remove some refrigerant 3. Increase water pressure 4. Increase water flow; use evaporative condenser 5. Clean or replace
		Capacity of condensing unit inadequate	Install larger motor and increase speed of compressor. Install larger unit

Complaint—One Room Too Warm

Possible Cause	Check	Details	Remedy
Conditioning unit fan not operating	Electrical connections	Test lead-in wires to see if current is reaching motor. If not, check fuses and wiring. Motor may be burned out	Replace fuse, repair wiring or replace motor
Not enough air flowing	Line voltage	A low line voltage will cause motor to operate slowly and not deliver enough air	Decrease load on circuit or increase wire size
	Filter	A dirty filter will restrict air flow	Clean or replace filter
No refrigerant reaching evaporator	Thermal expansion valve	Thermal expansion valve may prevent refrigerant from reaching the evaporator due to: 1. Valve has lost its charge 2. Strainer clogged 3. Ice formation in orifice. (Warm expansion valve to melt ice.) 4. Dirt clogging orifice	1. Replace valve 2. Clean 3. Install dehydrator or replace charge 4. Clean orifice
	Solenoid valve	Solenoid valve may not open due to: 1. Poor electrical connection 2. Burned out windings 3. Mechanism stuck	1. Clean and tighten all connections 2. Replace valve 3. Clean valve
Not enough refrigerant to evaporator	Thermal expansion valve	Refrigerant flow through expansion valve may be restricted 1. Valve badly out of adjustment 2. Orifice too small 3. Valve has lost part of its charge 4. Strainer is dirty 5. Ice formation in orifice. (Test by warming to melt ice.) 6. Dirt in orifice	1. Adjust 2. Replace with valve having larger orifice 3. Replace valve 4. Clean strainer 5. Install dehydrator or replace charge 6. Clean orifice
	Solenoid valve	Orifice in valve may be too small causing a large pressure drop or valve may not open fully. A temperature drop across the valve is an indication of too small an opening	Install valve with large orifice. Repair or replace valve
	Strainers	Strainers in liquid line may be restricting flow. A temperature drop across strainer indicates restricted flow	Clean all liquid line strainers
	Valve on liquid receiver	Valve on liquid receiver may be partially closed. A cold liquid line leaving receiver indicates partially closed valve	Open valve fully
	Liquid and suction lines	If liquid or suction line is too small or has a large number of bends there will be a high pressure loss decreasing the pressure drop across the expansion valve	Increase size of lines, decrease number of bends or install an expansion valve with a larger orifice
		If evaporator is located much higher than receiver pressure drop may cause some liquid to evaporate. The mixture of gas and vapor will reduce capacity of expansion valve	Subcool the liquid or install an expansion valve with a larger orifice

SEMI-CENTRAL SYSTEMS—WATER

Complaint—All Rooms Too Warm

Possible Cause	Check	Details	Remedy
No water flowing	Valves	A valve in water line to units may have been shut off	Open valve
	Strainers	A strainer may be clogged	Clean all strainers
	Electrical connections to pump motor	Test electrical connections and fuses in line to pump motor	Replace fuses or repair line
	Pump motor	Motor may be burned out	Replace motor
Not enough water flowing	Valves	Check all valves to make sure that they are opened fully	Open valves fully
	Strainers	A dirty strainer may be decreasing the velocity of the water	Clean all strainers
	Pipe	Water pipes should be checked to see if they are of proper size. Also pump capacity should be checked	Increase capacity of pump by increasing motor size. Install larger pump
	Voltage	If the line voltage is low the motor will not be able to drive the pump at the required speed	Decrease load on circuit or increase size of wires
Water temperature too high	Pipe insulation	All supply and return water pipes should be well insulated	Insulate all water pipes
	Water cooler	Water cooler may not be operating due to lack of refrigerant caused by: 1. Clogged thermal expansion valve 2. Frozen thermal expansion valve. Test by warming valve 3. Thermal expansion valve lost its charge 4. Float valve stuck closed or clogged 5. Strainers in refrigerant line clogged 6. Refrigerant line solenoid valve stuck shut	1. Clean strainer and orifice 2. Install dehydrator 3. Replace valve 4. Clean strainer and orifice 5. Clean 6. Repair or replace
	Condensing unit	Condensing unit not operating due to: 1. High-low pressure control out of adjustment 2. No current to compressor motor 3. Compressor motor burned out 4. Motor thermal overload open due to: (a) Failure of holding mechanism (b) Line voltage too low (c) Compressor belt too tight (d) Tight bearings 5. A high pressure caused by: (a) Air in system (b) Excessive refrigerant (c) Water supply insufficient (d) Water temperature too high (e) Dirty or clogged condenser	1. Adjust 2. Replace fuses 3. Replace motor 4. (a) Replace thermal overload switch (b) Decrease circuit load or increase wire size (c) Loosen belt (d) Oil or repair 5. (a) Purge system (b) Remove some refrigerant (c) Increase water pressure or pipe size (d) Increase water velocity or install an evaporative condenser (e) Clean
		Condensing unit not operating at full capacity due to: 1. Low line voltage 2. Belt driving compressor is loose 3. High head pressure caused by: (a) Air in system (b) Excessive refrigerant (c) Water supply insufficient (d) Water temperature too high (e) Dirty or clogged condenser	1. Decrease load on circuit or increase wire size 2. Tighten belt 3. (a) Purge system (b) Release some refrigerant (c) Increase water pressure or pipe size (d) Increase water velocity or install an evaporative condenser (e) Clean condenser
		Condensing unit does not have sufficient capacity. Check capacity against total heat load	Decrease heat load by shading windows, insulating, painting roof white

Complaint—One Room Too Warm

Possible Cause	Check	Details	Remedy
Conditioning unit fan not operating	Electrical connections	Test lead-in wires to see if current is reaching motor. If not, check fuses and wiring. Motor may be burned out	Replace fuse, repair wiring or replace motor
Not enough air flowing	Line voltage	A low line voltage will cause fan motor to operate slowly and not deliver enough air	Decrease load on circuit or increase wire size
	Filter	A dirty filter will restrict air flow. Evaporator coil may be found frosted up	Clean or replace filter
Not enough water flowing through cooling coil	Piping and valves	Check to see if all valves are open and pipe is of proper size. Make sure water is not short circuiting	Open valves fully. Increase water circulation. Correct piping connections
Air bound cooling coil	Air release valve	Air may be trapped in cooling coil	Open air release valve
Room unit capacity inadequate	Capacity against heat gain	Check the capacity of the unit against the heat gain of the room	Shade sunny windows, insulate walls or roofs or turn off appliances
Water temperature	Water temperature	Water to unit may be warm due to lack of insulation	Insulate pipes to room unit

CENTRAL SYSTEMS—DIRECT EXPANSION

COMPLAINT—ALL ROOMS TOO WARM

POSSIBLE CAUSE	CHECK	DETAILS	REMEDY
No air flowing	Dampers	Examine dampers to make sure they are in correct position	Open dampers
	Fan and motor	Motor may not be operating due to: 1. No current to motor 2. Low voltage 3. Motor burned out 4. Overload switch open because motor is overloaded	1. Replace fuses. Repair wiring 2. Decrease load on circuit or increase wire size 3. Replace motor 4. Install larger motor
Not enough air flowing	Motor	Motor may be too small to drive fan at proper speed	Install larger size motor
	Voltage	Line voltage may be low causing motor to operate below rated speed	Decrease load on circuit or install larger wire
	Fan belt	Fan belt may be loose and slipping	Tighten
	Intake duct	Intake opening and duct may be too small or dampers may be closed	Open dampers. Increase fan speed and motor size
	Air filters	Dirty air filters may be restricting air flow	Clean or replace air filters
	Dampers	Check all dampers to see if they are in correct position	Adjust dampers
	Duct size	Check all duct sizes to see if they are large enough to handle required amount of air	Increase speed of fan and motor size
Air is too warm	Condensing Unit	Condensing unit not operating due to: 1. High-low pressure control out of adjustment 2. No current to compressor motor 3. Compressor motor burned out 4. Motor thermal overload open due to: (a) Failure of holding mechanism (b) Line voltage too low (c) Compressor driving belt too tight (d) Tight bearings 5. A high head pressure caused by: (a) Air in system (b) Excessive refrigerant (c) Water supply insufficient (d) Water temperature too high (e) Dirty or clogged condenser	1. Adjust 2. Replace fuses or repair connections 3. Replace motor 4. (a) Replace thermal overload switch (b) Decrease load on circuit or increase wire size (c) Loosen belt (d) Oil or repair 5. (a) Purge system (b) Remove some refrigerant (c) Increase water pressure or pipe size (d) Increase water velocity or install an evaporative condenser (e) Clean
		Condensing unit not operating at full capacity due to: 1. Low line voltage 2. Belt driving compressor is loose 3. High head pressure caused by: (a) Air in system (b) Excessive refrigerant (c) Water supply insufficient (d) Water temperature too high (e) Dirty or clogged condenser	1. Decrease load on circuit or increase wire size 2. Tighten belt 3. (a) Purge system (b) Release some refrigerant (c) Increase water pressure or pipe size (d) Increase water velocity or install an evaporative condenser (e) Clean condenser
		Condensing unit does not have sufficient capacity. Check capacity against total heat load	Decrease heat load by shading windows, insulating, painting roof white

COMPLAINT—ONE ROOM TOO WARM

POSSIBLE CAUSE	CHECK	DETAILS	REMEDY
Conditioned air temperature too high	Conditioned air temperature	Duct to room may be uninsulated, thus allowing conditioned air to warm up	Insulate supply duct
Not enough conditioned air being supplied	Amount of conditioned air against heat load	Damper in duct partially or fully closed	Adjust or open damper
		Air splitter out of adjustment	Adjust air splitter
		Grille free area too small	Grille with more free area
		Duct area reduced by loose sound insulation	Refasten sound insulation
		Supply duct too small	Increase fan speed and readjust system
		No return duct or outlet	Install return duct or grille to allow return air to enter space which has return
		Return grille free area too small	Grille with more free area

Steam Piping Connections for Central-Fan and Gravity-Indirect Convectors

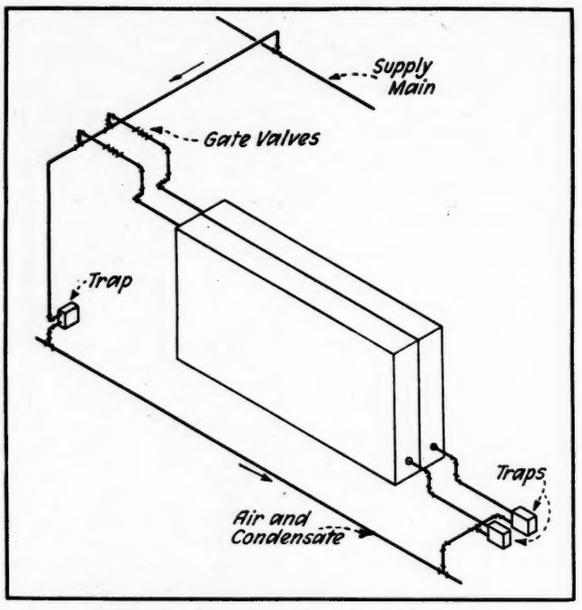


Fig. 1. Steam piping for a simple central fan convector.

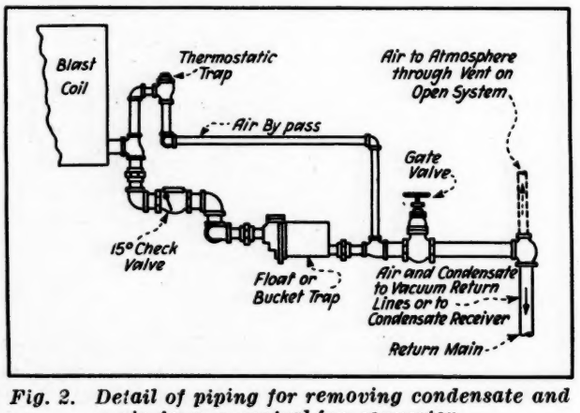

Blast Coil
Thermostatic Trap
Air to Atmosphere through Vent on Open System
Air By pass
Gate Valve
15° Check Valve
Float or Bucket Trap
Air and Condensate to Vacuum Return Lines or to Condensate Receiver
Return Main

Fig. 2. Detail of piping for removing condensate and air from a central-fan convector.

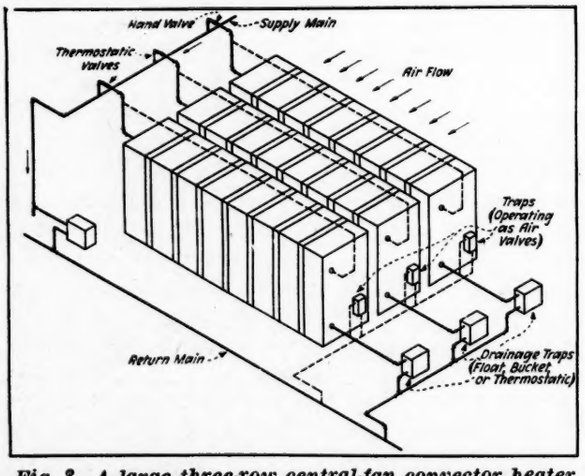


Fig. 3. A large three-row central-fan convector heater with steam piping arranged for three-stage heating.

HEATING surfaces over which air is forced at high speeds by a power-driven fan are steadily finding an increasing use. Not only are unit heaters an example of this practice but so also are room convectors and both unit and central air conditioners, central blast coil heaters, and many special installations arranged for factory process work.

Rapid condensation of steam, especially during heating-up periods, is characteristic of these surfaces. The piping must be planned to accommodate this rapid condensation, must keep the surfaces free of water, while on the supply side the piping must be ample to carry a full supply of steam to the surfaces to take the place of that condensed. Adequate size of pipe is thus essential to all heating surfaces over which there is a forced flow of air. Especially is this true where the fan is operated under start-and-stop control and where the air handled may be made up either wholly or partly of cold air from outside the building. In such installations the condensation rate may vary swiftly and the necessity for ample pipe capacity is especially acute.

These high condensation rates also make it necessary that the piping leading to and away from such surfaces be erected and installed with care. The sudden load changes mean that expansion and contraction of the piping take place quickly and all details of fitting must be watched to be sure that the provision for expansion is sufficient and so arranged that undue strains will not result. Likewise there must be no places where water can collect and lie in the piping where the next surge of steam or water will pick it up and cause water-hammering or where it will block the steady flow desired. Suitable sloping, enough supports and hangers, careful erection and well planned dripping and drainage are the defense against operating troubles due to the large and quickly changing condensation rate.

Generally, surfaces intended for use with forced circulation of air are planned and designed with the idea that separate and distinct piping will be provided for supply of steam and for disposal of entrapped air and condensate. While it is possible in some instances to use a one-pipe connection to such heaters this should not be done without assurance that the heating surface will function with this method of piping connection. It should be kept in mind that with a one-pipe connection, even though a sufficiently large pipe may be attached, the steam, air, and condensate must all pass through the hole provided in the heater for attaching the pipe.

In addition to these peculiar conditions piping for these heaters must also meet the universal requirement that it conform to the whole piping system so that not only these heaters, but all other steam-using equipment as well, will fit in with the general plan.

Figs. I and 3 should be regarded as typical rather than as exact since they are not to scale. While the sup-

ply pipe is shown as approaching the heater from above in both cases, this is not a necessary condition. It will be noted that in both these sketches the supply pipe is separately drained through a trap in order to be sure that no water collects in it. In cases where the length of the supply pipe is more than a bare minimum, this separate draining of the supply piping is generally considered a necessity. Figs. 1 and 3 also indicate that the return piping and traps are at a lower level than the bottom of the heaters. Such location is considered especially desirable and is usually a necessity in order that the pipes connecting the heater outlets to the traps may be sloped suitably and that condensate may reach the trap under gravity head.

Fig. 1 is a typical sketch of a simple installation of a fan convection heater from which sketch the fan has been omitted for simplicity. Direction of air flow over the heaters is at right angles to the direction of the supply and return mains. This sketch illustrates the installations frequently found where small basement air conditioners or small central fan systems are used. It will be noted that a separate trap is used for each heater and this is necessary when there are two supply pipes and two control valves. With this arrangement each section of the heater may be operated and controlled entirely independent of the other. In effect, this is thus a two-stage heater. Simple equipment now standard on the market is arranged as a one-stage heater to which the piping connections should be made as shown for either of the heaters in Fig. 1.

Fig. 2 illustrates in detail a method of piping on the return side of a fan convection coil which is much used and which is similar to that shown in Figs. 1 and 3 in principle but differs in detail. Here the air is passed through a thermostatic trap while the condensate passes through a float or bucket trap. In Figs. 1 and 3 the traps illustrated have a thermostatic element inside the trap body instead of in a separate body.

Traps are almost universally used on the return side of these fan convection heaters and are selected of a type which gives ample capacity to handle all the water and air which comes to them. Traps of the continuous flow type, such as bucket or float traps, are the ones generally suggested. On small installations, traps of other types are frequently suitable. Receivers of small size to catch the condensate are also sometimes used ahead of the trap.

Fig. 3 shows diagrammatically an installation of a bank of sectional fan convector heaters such as is found on large central fan installations. The illustration shows well how these heaters can be used with much flexibility since each row can be extended indefinitely as desired and as many rows as desired can also be installed. The figure indicates a heater made up of three rows of eight separate sections each. It is to be noted that the arrangement of piping and trapping shown results in a three-stage heater in which each stage can be operated and controlled as a separate heater. The upstream row can act as a tempering coil and is shown as under control of a hand valve while the other two are under thermostatic control. Note that the supply pipe to each row is shown as feeding into both ends of the row. This is an alternative to feeding into one end only and is frequently installed where the number of sections per row is great, the exact number where such auxiliary feed is required varying with the particular design of heater. Frequently, too, in long rows such as are found in large installations, auxiliary traps for removing air rapidly are installed midway of the row and led separately to the return main or to the atmosphere.

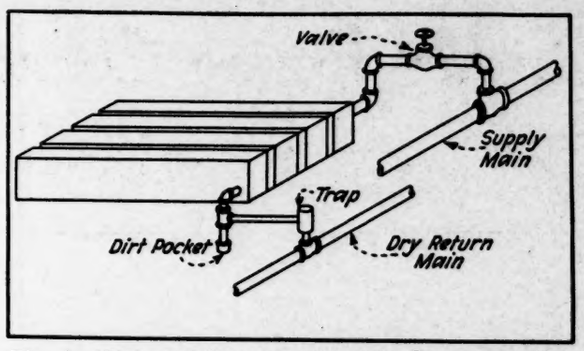


Fig. 4. Steam piping arrangement when a gravity-indirect convector is attached to a dry return main.

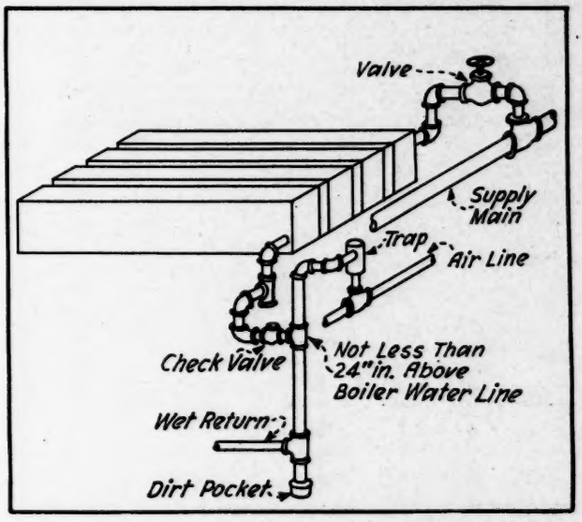


Fig. 5. Steam piping for connecting a gravity-indirect convector to a wet return and separate air line.

Indirect Gravity Convectors

These convectors are frequently installed under floors with no more clearance than absolutely necessary in order to keep down resistance to air flow due to long duct connections. Figs. 4 and 5 show diagrammatically examples of the piping connections usually used with these heaters. Fig. 4 illustrates the case where there is a dry return line and but little difference in height between the bottom of the heater and the return, while Fig. 4 shows a wet return line and a separate air line.

Condensation is not especially rapid with these heaters and their piping is essentially like the pipe connections made to other gravity heaters, such as direct tubular radiators and gravity direct convectors (see details of piping for such convectors in HEATING & VENTILATING, February, 1939). The supply main is shown separately dripped in both illustrations, although it is permissible to drip the supply line through the convectors in small installations. In Fig. 4 the trap passes both air and condensate which reach it by gravity flow. In Fig. 5 the trap passes only air which reaches it by rising in the vertical pipe when it separates from the water which falls to the wet return and thence to the boiler.

Let the Contractor Beware of Letters

By CHARLES R. ROSENBERG, Jr.†

WARNING a heating and ventilating contractor against letters is like warning him against his meals. He couldn't keep alive very long if he stopped eating and, modern commerce being what it is, he couldn't keep his business going for any length of time if he gave up writing and receiving letters.

Yet letters are loaded with a special kind of dynamite that unexpectedly may explode with disastrous effects on the helpless contractor's business and bankroll.

Of course, no contractor invites trouble by writing collection letters calling debtors crooks and dead beats. Nor do contractors, as a rule, write letters committing themselves to unsound deals and propositions. The contractor's good, hard sense keeps him out of that kind of letter trouble. No, it's those innocent-looking, routine letters that are apt to cause financial casualty; for there are twists and turns in ordinary letter-writing that the contractor discovers, usually, when it's too late for the knowledge to do him any good. That's what happened to Mac, a contractor in an eastern city.

Mac was in the market for equipment. He had obtained quotations from several houses. One day he got an interesting letter from a concern in the middle west. He didn't know them, but their price was low and their goods seemed to be exactly what he wanted.

"We cannot hold this offer open," the letter said. "If you want these goods at this extraordinarily low figure, send your acceptance of this offer by return mail."

Mac immediately wrote a letter of acceptance and mailed it. That was at eleven o'clock in the morning. At one o'clock in the afternoon a business friend walked into Mac's place.

"Mac," he said, "last week a contractor over in Milltown bought an outfit just like the one you're thinking about. He died suddenly; they had the funeral yesterday. His widow wants cash—and you can buy that outfit for about half of the ordinary price. It's practically new."

By four o'clock Mac had closed the deal with the widow. He wired the midwest concern to ignore his letter. The telegram, he knew, would reach them before the letter.

Within a few days he had a letter from the middle west. His letter accepting the "extraordinary offer" had been received and the goods would be shipped as soon as they could be packed. Not a word about his telegram.

"I'm afraid you're stuck, Mac," his lawyer told him. "As soon as you put your letter of acceptance in the mails, the contract was complete. You could not cancel the contract by your telegram. You received a bona fide offer asking for acceptance by return mail. Even if the offer had not specified acceptance by return mail, the result would be the same. The mailing of the letter of acceptance completes a legal contract. They can make you take the goods and pay for them. You'd better make some kind of settlement with them."

Even where a contractor gets a letter making him a direct, personal offer of certain equipment or stock at a certain price and terms, he cannot clinch the deal for himself unless he accepts the proposition exactly as it is made. Suppose, for example, the offering letter specifies terms ten days net. If the contractor in his letter accepting the offer, says, "I'll pay thirty days net," he has not accepted the offer at all. If he wants to bind the other fellow legally, he must accept *all* the terms of the offer; otherwise there is no acceptance. A letter accepting an offer with even slight changes from the terms of the original offer is in law a *refusal* of the offer and constitutes a so-called counter-offer. In other words, the other fellow then has the right either to accept or reject the changed terms.

Heating contractors sometimes get into the middle of a transaction and then find it necessary or at least expedient to make some changes in the arrangements or terms. A contractor in such a predicament is apt to write a letter explaining the proposed changes to the other fellow and conclude by saying, "If I do not hear from you to the contrary within a week, I shall assume this is satisfactory to you and be guided accordingly."

He may be guided accordingly, but in doing so he's giving the other man a splendid opportunity to slide out of the deal. A man's mere silence is not enough to bind him to the changed terms. The law does not recognize a "mental acceptance." If the contractor wants to be safe, he must get the other man to signify his agreement by word or writing or even some appropriate act of acceptance. That business of "not hearing from you to the contrary" is apt to leave the contractor at the other fellow's mercy.

Contractors in disputes with customers and others are often willing to make compromises, but are fearful of writing letters offering concessions lest the letters seem to weaken the contractor's position in any subsequent lawsuit. Ordinarily, compromise offers made in the course of negotiations to settle a controversy cannot be used in evidence against the person making the offers. It's safe, as a rule, to make offers of compromise, but not safe to admit any material facts that might be damaging if the case should be tried in court. And even in making offers of compromise, it's wise to say at the end of the letter: All the above is without prejudice and solely with a view to amicable settlement.

He was stuck with the contract—it was not cancelable!

†Attorney-at-Law, Media, Pa.

Bureau of Standards Issues Standards for Mechanical Draft Oil Burners

THE National Bureau of Standards on February 27 issued in mimeographed form the Proposed Commercial Standard for Mechanical Draft Oil Burners as submitted by the Oil Burner Industry Standards Committee on February 17, at which time the committee requested that it be established as a Commercial Standard.

The Bureau, through I. J. Fairchild, Chief, Division of Trade Standards, has called a conference of manufacturers, distributors, and installing contractors of mechanical draft oil burners for 10 a.m., March 15, in Room A, Chamber of Commerce of the United States, 1615 H St., N.W., Washington, D. C., in order to harmonize the views of those concerned with the requirements and tests of oil burners both before and after installation as a basis for fair competition, better understanding between buyer and seller, and improved public confidence in oil burners. The meeting will be opened to all interested parties.

Mr. Fairchild will, in opening the meeting, outline the procedure in adopting commercial standards, and will be followed by R. M. Sherman, chairman of the Oil Burner Industry Standards Committee, who will talk of the Objective in Establishing a Commercial Standard for Oil Burners. These talks will be followed by a discussion and vote on the proposed Standard.

Mr. Fairchild stated in an interview that:

"It is expected that the conference will ratify, either in its present form or with minor changes, the proposed commercial standards for mechanical draft oil burners. Such action would be followed in about 30 days by a public hearing in Washington, with installing contractors, engineers, architects, and consumers joining manufacturers and distributors in the discussions.

"The final step would be a mail poll conducted by the Bureau of Standards. Upon receipt of signed statements of approval from proper executives representing 65% of the industry's production capacity, the data would be published by the U. S. Department of Commerce as a recorded statement of the industry.

"Standards thus recorded would thereafter be required for installation in FHA-insured homes and would rapidly become the yardstick by which all oil burner installations would be measured."

The proposed Commercial Standards for Mechanical Draft Oil Burners as issued by the Bureau follow:

Purpose

1. The purpose is to establish standard specifications and methods of test for mechanical draft oil burners for the guidance of manufacturers, distributors, installing contractors and users.

Scope

2. This standard covers: (a) Manufacturing and production tests; (b) Laboratory requirements and test procedure; (c) Installation requirements and performance tests; (d) Oil Burner Certificate placed with each burner installation.

Manufacturing and Production Tests

3. The following standards apply to manufacturing and production tests on mechanical draft oil burners:

PRODUCTION TESTS ON PRESSURE OIL BURNERS

4. Each burner shall be manufactured and tested according to the following procedure:

4(a). Burners shall be manufactured so that: (1) Proper alignment between motor and pump shaft is assured. (2) All parts are interchangeable. (3) To provide reasonable freedom from vibration and wear it is recommended that, where the alignment of motor and pump shafts is controlled by machine surfaces, the maximum tolerance on each such controlling dimension shall not exceed .005 inch as total tolerance: where alignment is not controlled from machined surfaces leveling means or equivalent shall be provided to obtain an accuracy equivalent to that recommended above. (4) Motor and pump shall be securely mounted in such manner that the alignment of these two units shall remain permanent within the tolerances specified above. (5) Motor load shall not exceed its rated capacity. (6) Ignition points of electrodes shall be made of heat resisting material and securely fastened to avoid change of location.

(Continued on next page)

OIL BURNER CERTIFICATE

.....
(Name of Manufacturer) (Address)

Manufacturer of.....Oil Burner guaranteed Model ....., Serial No. .....

THIS SPACE FOR MANUFACTURER'S ENTIRE WARRANTY

This burner is approved for use with fuel oil not heavier than Commercial Standard Grade No. ....

The oil burner installed in Boiler {Name..... No.....} Furnace {Name..... No.....} with ..... square feet of standing steam..... hot water..... radiation plus ..... square feet of additional connected load; or with ..... square inches cross section area of warm air supply pipes measured at the furnace take off.

Other Special Data: .....

.....

at ..... and has been installed by
(Address)

.....
(Name of Installer and Address)

in accordance with specifications in Oil Burner Manufacturers' Instruction Manual.

This installation has been installed to comply with all local regulations, codes, and ordinances and required permits have been secured; and has been tested in accordance with test procedure of Oil Burner Industry Standards Committee and readings taken as follows:

CO_2.....
Draft {Over Fire..... At Breeching.....} inches H_2O
Fuel Used CSG. No.....

Stack Temperature at breeching with shielded thermometer .....° F.
Firing Rate ..... gals./hr.

The above test results are certified to be true.

.....
(Company)

Date..... Per.....
(Signature)

24 hour service on this oil burner installation without charge is guaranteed for a period of one year from ..... by
(Date)

.....
(Company)

Per.....
(Signature)

Telephone.....

Oil Burner Certificate which the new Standard requires to be filled in and placed with each oil burner installation.

4(b). Each assembled burner shall be bench-tested for a suitable period of time:

(1) To reveal and eliminate: (a) Oil leaks; (b) Electrical defects; (c) Mechanical noise and vibration.

(2) To determine: (a) Pressure regulating valve adjustment; (b) Total motor load; (c) Proper functioning of ignition means (with or without actual fire test).

4(c). Each burner shall be tested at the maximum rated pressure recommended by the manufacturer in his installation manual, but in no case at less than 100 pounds for high pressure atomization burners: for low pressure and horizontal rotary domestic burners the burner shall be tested at the maximum pressure recommended in the manufacturers' installation manual.

4(d). Upon inspection at the conclusion of the operating tests each burner shall be inspected for air gap between electrodes and relation of electrodes to nozzle and shall be in accordance with the specifications contained in the manufacturer's manual for that particular model.

Production Tests on Wall Flame and Atomizing Vertical Rotary Burners

5. Each burner shall be manufactured and tested according to the following procedure:

(1) Tolerances of all parts shall be established and checked with suitable gauges or fixtures so that they can be assembled into assemblies without altering the parts.

(2) Motor shall operate as an assembly (motor and driven parts) and be checked for: (a) Quiet operation; (b) Shaft alignment.

(3) Oil distributing device shall be inspected for: (a) Tube angle; (b) Tube concentricity.

(4) Fan shall be inspected for balance and run out.

(5) Igniters shall be inspected for: (a) Spark gap; (b) Insulation.

(6) Oil valve in its manufacture shall be tested for leakage.

(7) Igniter lead wire shall conform to Underwriters' specifications in all respects.

Laboratory Requirements and Test Procedure

6. The following standards apply to laboratory requirements and test procedure for mechanical draft oil burners:

Burner Construction

7(a). *Long Hour Motor.*—Oil burner motor service may be assumed to be equivalent to continuous operation and the motor shall be of ample capacity and designed for long hour duty, and be so designated (motor name plate shall bear the words "long hour duty") by the motor manufacturer.

7(b). *Definition.*—A long hour duty motor shall conform to NEMA specifications for long hour duty motors.

7(c). *Test Procedure.*—The motor shall be of long hour specification and its name plate rating shall equal or exceed the load occurring when the burner is operated with air adjustment full open with maximum size fan and oil pressure at maximum recommended by the manufacturer in his installation manual.

8(a). *Radio Interference.*—The burner shall be reasonably free from radio interference.

8(b). *Test Procedure.*—The standard of freedom from radio interference shall be determined by a radio receiver of known sensitivity located in the same room with the burner and connected to the same power supply. A signal exceeding ..... intensity shall indicate excessive interference. The signal strength standard shall be determined by the test laboratory as the result of accumulated experience, subject to approval of the Oil Burner Industry Standards Committee.

9(a). *Quietness.*—The burner shall be reasonably free from disturbing combustion or mechanical sound.

9(b). *Test Procedure.*—The standard for sound level shall be determined by the test laboratory as the result of accumulated experience, subject to the approval of the Oil Burner Industry Standards Committee.

Burner Performance Ratings

10(a). *CO_2 Rating.*—Burner shall be capable of producing and maintaining a CO_2 of not less than 10 per cent without visible smoke at oil rates of one gallon and over. At oil rates of less than one gallon per hour the minimum CO_2 shall be 8 per cent.

10(b). *Test Procedure.*—The burner under test shall be installed in accordance with specifications in manufacturer's installation manual. Test procedure to begin with manufacturer's minimum rating and steps of not more than one gallon to maximum. The entire boiler or furnace combustion passage from burner to flue gas outlet shall be tight against air leakage. The gas sample for analysis shall be taken at the boiler or furnace flue gas outlet. The draft value in the combustion chamber for this test shall be in accordance with the manufacturer's specifications. This same draft value shall be used in determining the maximum burning rate.

10(c). Air not supplied by burner fan or blower shall not be permitted in determining maximum burning rates for full mechanical draft burners. Where maximum burning rates are designated by manufacturer with partial mechanical draft such maximum burning rates shall be qualified in terms of minimum draft and port area in manufacturer's manuals, rating and instruction sheets. Where burners are *designed* for partial mechanical draft the maximum burning rates shall be qualified in terms of minimum draft and port area in manufacturer's manuals, rating and instruction sheets.

11. *Smoke Determination* (Test Procedure).—Determination for smoke shall be made by means of a sampling tube by passing a section of the flue pipe and a photo-electric cell unit applied to the sampling tube, or equivalent means. The detecting means shall detect no smoke in a lengthwise section of the sampling tube not less than four feet long.

Burner Safety

12(a). *Safety Standard.*—The burner shall meet the safety standards of Underwriters' Laboratories, Inc. Standard for Domestic Oil Burners (Subj. 296), March, 1934.

12(b). *Test Procedure.*—In accordance with above. (Presence on the burner of label of Underwriters' Laboratories, Inc., shall be accepted as evidence of compliance with this safety requirement.)

Burner Guarantees

13(a). *Guarantee.*—Burner and burner controls shipped with the burner shall be guaranteed by the burner manufacturer against defects of material and workmanship for a period of one year from date of installation.

13(b). *Test Procedure.*—Each manufacturer shall certify to the laboratory that every burner with its controls shipped by him bearing the seal of the authorized laboratory is guaranteed against defects of material and workmanship for a period of one year from date of installation.

Burner Test Arrangement

14. *Manuals.*—Printed comprehensive service and installation manual shall be submitted by the burner manufacturer to the authorized laboratory for approval. Manufacturer shall be required to send copy of his service and installation manual to each of his authorized dealers.

15. *Tests.*—Burner tests for certification shall be conducted according to test procedure formulated by the Oil Burner Industry Standards Committee and approved by the oil burner industry.

Installation Requirements and Performance Tests

16. The burner shall be of adequate size for the boiler or furnace and the connected heating load as recorded on the Oil Burner Certificate by the installer.

(Concluded on page 76)

The Flow of Air and Its Distribution Through Ducts

Part 2—Flow with Friction—Ducts with Equal Friction

By J. R. ZWICKL†

IN the previous article flow *without* friction was described and the formulas developed. We will now turn our attention to flow *with* friction.

Flow of Air with Friction

General Formula for Pressure Loss: When a fluid (liquid or gas) moves in a closed duct then, due to the viscosity of the fluid, there is a frictional resistance between the wetted surface of the duct and the fluid causing a drag, so that it is necessary to apply a force on the fluid in the direction of flow to counteract this frictional resistance.

If A is the cross-section area of the duct in square feet, U its inside circumference (wetted perimeter) in feet, l the length of the duct in feet, then we can write:

$$F = A\,(P_1 - P_2) = sUlm\left(\frac{c^2}{2g}\right) lb. \quad \ldots\ldots\ldots (15)$$

where F is the force in pounds, P_1 is the fluid pressure at the beginning of the duct, P_2 at the end of it, so that $(P_1 - P_2)$ is the pressure loss in pounds per square foot for the l feet of length of duct due to friction along the Ul square feet of wetted surface; $m\left(\frac{c^2}{2g}\right)$ is the velocity pressure in pounds per square foot as before —see equation (4)—and s is the "friction-factor," which has no dimension.

If we express the velocity as v feet per minute and the pressure loss in inches of water as $(P_1 - P_2) = 5.2h'$, we can modify equation (15) into:

$$h' = \frac{(P_1 - P_2)}{5.2} = s\left(\frac{U}{A}\right) lm\left(\frac{v}{1098}\right)^2$$

$$= s\left(\frac{U}{A}\right) l\left(\frac{m}{m_o}\right)\left(\frac{v}{4000}\right)^2 \quad \ldots\ldots\ldots (16)$$

which gives the true head loss (h') expressed in terms of the true velocity head. See equations (5) and (5a).‡ For standard density $(m = m_o = {}^{7.5}/_{100}$ *pounds per cubic foot)* this equation will be:

$$h'_o = s\left(\frac{U}{A}\right) l\left(\frac{v}{4000}\right)^2 \text{ in. of water} \ldots . (17)$$

This we may call the *apparent head loss,* which in case of non-standard conditions must be corrected for the true density:

$$h' = \left(\frac{m}{m_o}\right) h'_o = \left(\frac{b}{b_o}\right)\left(\frac{T_o}{T}\right) h'_o \quad \ldots\ldots\ldots (18)$$

so as to get the true head loss for the existing conditions.

Equation (17) is the one commonly used; it holds good for any type of duct. Applying it to round ducts, with diameter of d feet, we find that $U/A = 4/d$ and the equation modifies to:

$$h'_o = f\left(\frac{l}{d}\right)\left(\frac{v}{4000}\right)^2 = \frac{1}{C}\left(\frac{l}{d}\right)\left(\frac{v}{4000}\right)^2 \quad \ldots\ldots (19)$$

wherein $f = 4s = 1/C$. From equation (19) it is evident that when $l = Cd$ then h'_o equals one velocity head. For this reason it has been customary to express the duct length l in terms of diameters and take one velocity head as the loss for every C diameters. For normal well-made galvanized iron ducts $C = 50$ is ordinarily used, while for poorly-made ducts $C = 45$, and very smooth ducts $C = 55$.*

Correct Formula for Pressure Loss: The above method of figuring would be all right if $f = 1/C$ would be constant. However, this is not the case. Many experimenters have proven that f decreases with increasing diameter and velocity. Especially, Fritzsche has shown that:

$$f\,(d^{2/7}\, v^{1/7}) = f_o\,(d_o^{2/7}\, v_o^{1/7}) = \text{a constant},$$

where f_o is the value of the friction factor for a specified d_o diameter and v_o velocity. When $d_o = 2$ ft. and $v_o =$ 2000 f.p.m. we know that $f_o = 1/C = 0.02$. With this used as a base value we find that $4s = f = \dfrac{3.6}{Cd^{2/7}v^{1/7}}$ where C has the same value 50 as before (or 45 or 55 depending on the surface quality).

Putting this expression for f into equation (19) we get:

$$h'_o = \frac{1.1}{C}\,\frac{l}{d^{9/7}}\left(\frac{v}{4000}\right)^{13/7} \text{in. of water} \quad \ldots\ldots (20)$$

as the most correct formula for figuring the friction loss in round ducts for standard density air.

In equation (20) C is merely a constant, its value depending on the surface quality of the pipe; it no longer has the meaning it has in equation (19), excepting for the reference case of $d_o = 2$ *ft.* and $v_o =$ *2000 f.p.m.* For this reason it is more convenient to write equation (20) for $l = 100$ *ft.* With $C = 50$ this will be:

$$(h'_{oo}) = \frac{2.2}{d^{9/7}}\left(\frac{v}{4000}\right)^{13/7} \text{in. of water} \quad \ldots\ldots (21)$$

†Worthington Pump & Machinery Corp., Carbondale Div., Harrison, N. J.

‡The head loss due to friction, etc., is designated by the prime mark (') with corresponding indexes.

*Note the distinction between f and s; s is the friction factor in general, whereas $f = 4s$ is good only for round ducts.

where h'_{oo} is the friction loss for 100 ft. of duct length at *standard air density*. If the air density is not standard, equation (21) does not give the true value of this friction loss. Therefore, for non-standard conditions we may call (h'_{oo}) the "apparent friction loss," which must be corrected by equation (18) to obtain the true value of the friction loss:

$$h'_{100} = (h'_{oo})\left(\frac{m}{m_o}\right)$$

Table 1 gives the values of $d^{9/7}$ for duct diameters from 4 in. to 120 in. Similarly Table 2 gives the values of $\left(\frac{v}{4000}\right)^{13/7}$ for velocities from 250 to 6000 ft. per min. Both tables can be used for linear interpolation to obtain intermediate values. By means of these data, equation (21) can be handled easily.

If we express the velocity v by the relation $\frac{d^2\pi}{4} v =$ Q *c.f.m.*, we can modify equation (21) into

$$(h'_{oo}) = \frac{2.2}{\pi^{13/7}} \frac{(Q/1000)^{13/7}}{d^5} = 0.262 \frac{(Q/1000)^{13/7}}{d^5} \quad \ldots\ldots (22)$$

One of the most commonly used friction charts is based on equations (21) and (22). It is a logarithmic plot giving $(h'_{oo}) = f(Q)$ for different values of d and v, these being plotted as straight lines crossing each other at an angle of about 85½°. The values of this chart are for *standard density* ($m_o = {}^{7.5}/_{100}$ lb. per cu. ft.) conditions. They must be corrected according to equation (18) if the temperature and pressure are not standard. By means of Tables 1 and 2 it is easy to figure for the selected round values of d and v the corresponding values of (h'_{oo}) and $Q = \frac{d^2\pi}{4} v$ and then plot them on a logarithmic paper with a large enough scale so as to make the chart easily readable.

If we want to apply the variable friction factor to the general formula (17) for ducts other than round we have to substitute in the formula for $f = 4s$ the diameter with $d = 4\left(\frac{A}{U}\right)$. Doing so, we get, for the duct length $l =$ 100 ft., and for standard density:

$$(h'_{oo}) = 2.2 \left(\frac{U}{4A}\right)^{9/7} \left(\frac{v}{4000}\right)^{13/7} \quad \ldots\ldots (23)$$

and if we substitute in (23) $v = \left(\frac{Q}{A}\right)$, we find

$$(h'_{oo}) = 2.2 \frac{U^{9/7}}{(4A)^{22/7}} (Q/1000)^{13/7} \quad \ldots\ldots (24)$$

TABLE 1. VALUES OF $d^{9/7}$ FOR DIAMETERS FROM 4 TO 120 IN.

d, Inches	$d^{9/7}$	d, Inches	$d^{9/7}$
4	.243	30	3.250
5	.324	32	3.530
6	.410	34	3.815
7	.500	36	4.108
8	.594	38	4.405
9	.691	40	4.705
10	.791	45	5.470
11	.894	50	6.270
12	1.000	55	7.100
13	1.108	60	7.930
14	1.218	65	8.800
15	1.332	70	9.660
16	1.448	75	10.55
17	1.564	80	11.48
18	1.684	85	12.40
19	1.805	90	13.35
20	1.929	95	14.32
22	2.180	100	15.30
24	2.438	105	16.28
26	2.703	110	17.28
28	2.975	115	18.30
30	3.250	120	19.35

TABLE 2. VALUES OF $\left(\frac{v}{4000}\right)^{13/7}$ FOR VELOCITIES FROM 250 TO 6000 F P.M.

v, F.P.M.	$\left(\frac{v}{4000}\right)^{13/7}$	v, F.P.M.	$\left(\frac{v}{4000}\right)^{13/7}$
250	.0058	2000	.276
300	.0081	2200	.330
350	.0108	2400	.388
400	.0139	2600	.449
450	.0172	2800	.516
500	.0210	3000	.586
600	.0296	3200	.660
700	.0392	3400	.740
800	.0502	3600	.822
900	.0625	3800	.909
1000	.0760	4000	1.000
1100	.0910	4200	1.095
1200	.1073	4400	1.194
1300	.1245	4600	1.296
1400	.1425	4800	1.403
1500	.1615	5000	1.514
1600	.1825	5200	1.628
1700	.204	5400	1.746
1800	.227	5600	1.868
1900	.251	5800	1.995
2000	.276	6000	2.125

Ducts with Equal Friction Loss per Foot of Length

Ducts of Equivalent Capacity: Two ducts are equivalent, if they carry the same air volume Q with the same pressure loss for equal length. From equation (24) we see that this will be the case if the numerical value of:

$$\frac{(4A_1)^{22/7}}{(U_1)^{9/7}} = \frac{(4A_2)^{22/7}}{(U_2)^{9/7}}$$

whatever shape the cross section of the ducts may be. If one of the ducts is round, with the diameter d, and the other one rectangular with the sides B and H, the above formula becomes:

$$d^5 \pi^{13/7} = \frac{(4BH)^{22/7}}{[2(B+H)]^{9/7}}$$

We arrive at the same result by combining equation (22) with (24). From the above equation we find that:

$$d = 1.307 \frac{(BH)^{0.639}}{(B+H)^{0.257}} \quad \ldots\ldots (25)$$

By means of equation (25) we can calculate for any given rectangular duct *(B-H)* the diameter for the equivalent round duct; the reverse is possible only by trial and error. For this reason it is customary to figure beforehand for assumed even values of B and H the corresponding values of d and tabulate them, so that from such tabulation we can pick out (by interpolation) corresponding values of *B-H* and d.

Reference books give such tabulations. However, the given values are not figured by means of the correct equation (25), but from the somewhat simpler equation

$$d = 1.265 \frac{(B\,H)^{0.6}}{(B+H)^{0.2}}$$

which can be derived from the basic friction loss formula with f taken as constant. For square and nearly square cross section these equations give almost the same results for d. For larger aspect ratios the correct formula (25) gives for d smaller values than the other formula.

The relation between B-H and d, as given in equation (25) can be simplified considerably by introducing b, the aspect-ratio: $b = B/H$ *or* $B = bH$. If we substitute this value for B in (25) in this way, our equation modifies into:

$$d = H\left[1.307\ \frac{b^{0.629}}{(1+b)^{0.257}}\right] = kH \ldots\ldots\ldots (26)$$

where:

$$k = d/H = \left(1.307\ \frac{b^{0.629}}{(1+b)^{0.257}}\right) = f(b). \ \ldots (27)$$

For any practical rectangular duct the value of b lies between 0.4 and 6. Thus we can figure the value of k beforehand for assumed values of b and tabulate them as corresponding values; or still better, we can plot these values as a curve: $k = f(b)$. Table 3 and Fig. 1 give these $k = f(b)$ values.

With such data on hand, the problem is very simple. If we know B and H, we figure $b = B/H$, then find for this b the corresponding value of k from the curve and finally figure $d = kH$. By means of these b-k data, however, we can figure also to any d the corresponding B-H values.

We see from equation (26), that $d/H = k$. Having selected H (one side of the rectangular duct to suit the structural conditions of the building) we compute the value of $k = d/H$, find for this k the corresponding value of b from the curve, and finally we find $B = bH$. This way of handling the problem is especially convenient, if we have to lay out the duct system so that one side *(H)* is kept constant and the other side *(B)* is figured to satisfy a series of predetermined diameters of equivalent round ducts.

TABLE 3. VALUES OF k FOR VARIOUS ASPECT RATIOS (b)*

b	k	b	k	b	k
0.30	0.573	2.10	1.560	4.60	2.190
0.35	0.626	2.20	1.592	4.70	2.210
0.40	0.675	2.30	1.625	4.80	2.230
0.45	0.720	2.40	1.655	4.90	2.250
0.50	0.762	2.50	1.687	5.00	2.270
0.55	0.803	2.60	1.715	5.10	2.290
0.60	0.840	2.70	1.745	5.20	2.310
0.65	0.877	2.80	1.772	5.30	2.325
0.70	0.910	2.90	1.800	5.40	2.340
0.75	0.943	3.00	1.825	5.50	2.360
0.80	0.977	3.10	1.852	5.60	2.380
0.85	1.007	3.20	1.880	5.70	2.395
0.90	1.038	3.30	1.903	5.80	2.410
0.95	1.066	3.40	1.928	5.90	2.430
1.00	1.095	3.50	1.950	6.00	2.450
1.10	1.145	3.60	1.975	6.10	2.460
1.20	1.198	3.70	2.000	6.20	2.480
1.30	1.245	3.80	2.022	6.30	2.495
1.40	1.288	3.90	2.045	6.40	2.510
1.50	1.335	4.00	2.067	6.50	2.525
1.60	1.375	4.10	2.090	6.60	2.540
1.70	1.415	4.20	2.110	6.70	2.560
1.80	1.452	4.30	2.130	6.80	2.575
1.90	1.490	4.40	2.150	6.90	2.590
2.00	1.525	4.50	2.170	7.00	2.600

*The data in this table are plotted in graph form in Fig. 1, which see.

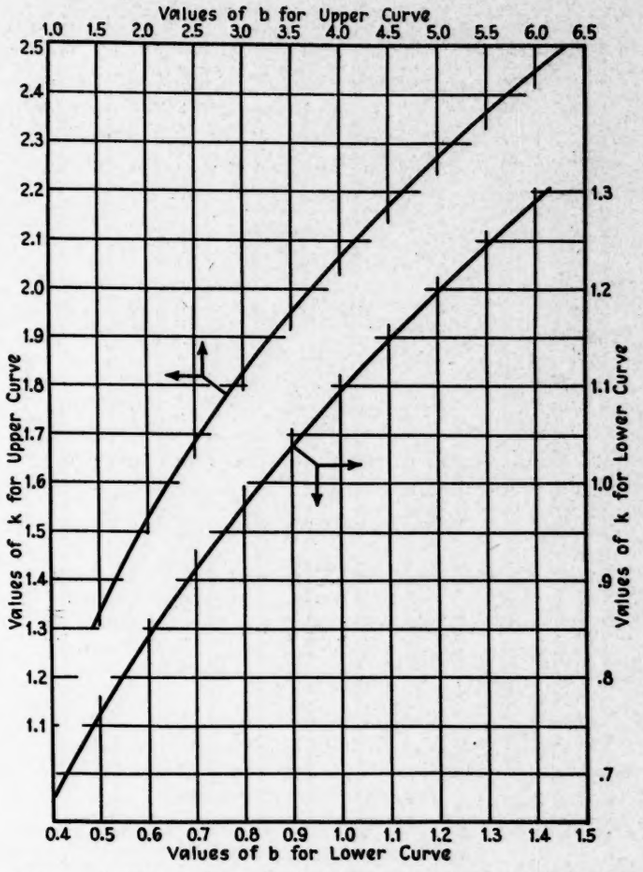


Fig. 1. A plot of the relationship of k *and* b. *This is the same data as appear in Table 3 in tabular form. The following formulas are useful in using either Fig. 1 or Table 3:*

$$b = \frac{B}{H}\ ;\ k = \frac{d}{H}\ ;\ k = 1.307\ \frac{b^{.629}}{(1+b)^{.257}}$$

Ducts of Unequal Capacity but Equal Pressure Loss: This is the case of branch ducts, which carry only a certain part of the main air quantity, but should have the same friction loss per foot.

If Q_1 is the air quantity (in c.f.m.) carried by duct No. 1, with the diameter d_1 and Q_x the air quantity of duct No. x having the diameter d_x, then, if these two ducts should have an equal pressure loss per foot, they must satisfy the relation:

$$\frac{(Q_1)^{1.9/1}}{(d_1)^5} = \frac{(Q_x)^{1.9/1}}{(d_x)^5}$$

as can be seen from equation (22). We can modify this into:

$$\left(\frac{d_x}{d_1}\right) = \left(\frac{Q_x}{Q_1}\right)^{1.9/5} = q_x^{1.9/5} = q_x^{0.372} \ldots\ldots (28)$$

where $q_x = (Q_x/Q_1)$ is the *capacity ratio* and (d_x/d_1) is the *diameter ratio* for the two ducts considered.

Obviously, the two ducts must also satisfy equation (21), that is the relation:

$$\frac{v_1^{1.9/1}}{d_1^{9/1}} = \frac{v_x^{1.9/1}}{d_x^{9/1}}$$

from which we find:

TABLE 4. VALUES OF q_x, d_x AND j_x FOR PROPORTIONING BRANCH DUCTS AND ELBOWS

q_x	d_x	j_x	q_x	d_x	j_x	q_x	d_x	j_x
1	18.0	.094	34	67.0	.575	67	86.2	.815
2	23.3	.133	35	67.7	.583	68	86.6	.820
3	27.1	.164	36	68.4	.591	69	87.1	.826
4	30.0	.189	37	69.1	.600	70	87.6	.832
5	32.8	.214	38	69.8	.608	71	88.0	.838
6	35.2	.235	39	70.5	.616	72	88.5	.845
7	37.2	.255	40	71.2	.624	73	88.9	.851
8	39.2	.273	41	71.8	.632	74	89.4	.857
9	40.9	.290	42	72.4	.640	75	89.8	.862
10	42.5	.306	43	73.1	.648	76	90.3	.869
11	44.0	.323	44	73.7	.655	77	90.7	.875
12	45.5	.337	45	74.3	.663	78	91.2	.880
13	46.9	.352	46	74.9	.671	79	91.6	.886
14	48.2	.365	47	75.6	.679	80	92.0	.892
15	49.4	.377	48	76.1	.685	81	92.4	.898
16	50.6	.390	49	76.7	.693	82	92.9	.904
17	51.8	.403	50	77.3	.700	83	93.3	.910
18	52.9	.415	51	77.8	.707	84	93.7	.915
19	53.9	.425	52	78.4	.715	85	94.1	.920
20	55.0	.437	53	79.0	.722	86	94.5	.925
21	56.0	.448	54	79.5	.730	87	94.9	.931
22	57.0	.460	55	80.1	.736	88	95.3	.936
23	57.9	.470	56	80.6	.742	89	95.7	.942
24	58.8	.480	57	81.1	.749	90	96.1	.947
25	59.7	.490	58	81.7	.756	91	96.5	.953
26	60.6	.500	59	82.2	.763	92	96.9	.958
27	61.5	.510	60	82.7	.769	93	97.3	.964
28	62.3	.520	61	83.2	.775	94	97.7	.969
29	63.1	.530	62	83.7	.782	95	98.1	.975
30	63.9	.538	63	84.2	.789	96	98.4	.980
31	64.7	.547	64	84.7	.796	97	98.8	.985
32	65.5	.556	65	85.2	.802	98	99.2	.990
33	66.2	.565	66	85.7	.808	99	99.6	.995
						100	100.0	1.000

q_x = *per cent of* Q_1 $\qquad$ d_x = *per cent of* d_1

$$j_x = \left(\frac{v_x}{v_1}\right)^2 = \frac{(v_x/4000)^2}{(v_1/4000)^2}$$

$$\left(\frac{v_x}{v_1}\right) = \left(\frac{d_x}{d_1}\right)^{9/13} = \left(q_x^{13/35}\right)^{9/13} = \left(q_x\right)^{9/35} \quad \ldots\ldots (29)$$

as the *velocity ratio* for the two ducts expressed in terms of the *diameter ratio* or *capacity ratio.*

From equation (29) we finally get:

$$j_x = \left(\frac{v_x}{v_1}\right)^2 = \left(\frac{d_x}{d_1}\right)^{18/13} = \left(q_x\right)^{18/35} \quad \ldots\ldots (30)$$

where j_x is the *velocity-head ratio* for the two ducts expressed in terms of the *diameter ratio* or of the *capacity ratio.*

Table 4 gives the values of the *diameter-ratio* (d_x/d_1), that is d_x in per cent of d_1, and the values of the *velocity-head ratio* $j_x = \left(\frac{v_x}{v_1}\right)^2$ parallel to the corresponding values of the capacity-ratio q_x (with q_x in per cent of Q_1).

If we know the data for the main duct (Q_1, d_1, v_1, etc.) then by means of these equations or Table 4 we can easily figure for any branch duct (x) the diameter d_x, the velocity, and velocity-head for this branch, if we know how many per cent $(= q_x)$ of the main air (Q_1) this branch has to carry. And if we make the diameter of this branch duct as figured, then its pressure loss per foot length will be the same as for the main duct. This is the beauty of the whole matter, because, when summing up all duct resistances, each branch duct can be substituted in the calculation by an equally long stretch of the main duct.

The third installment of this series will appear in next month's issue.

Contractors Want Larger Drawings

THE following resolution for the elimination of small-scale drawings was adopted at the 49th annual convention of the Heating, Piping and Air Conditioning Contractors National Association.

"WHEREAS: The furnishing of small-scale drawings and specifications and insufficient information necessary to intelligently prepare an estimate has caused serious loss to the members of this industry; therefore, be it

Resolved: That it is recommended that proper plans and specifications shall be furnished for the preparation of a bid showing and describing all the work to be bid upon. It is further recommended that no plans, except block plans, shall be drawn to a scale less than one-eighth inch to the foot. When one-eighth inch scale plans fail to adequately show or describe the work it is recommended that larger scale drawings shall be provided to indicate the requirements."

A Simple Method for Obtaining Daily Temperatures and Degree-Days

By C. E. MENGEL†

WHILE the use of temperature data is increasing in the fuel business, methods of obtaining them daily all present some gap or lag, or else the method is burdensome. Also, in all cases, the temperatures obtained must be subtracted from 65 to get degree-days.

To simplify the obtaining of the data daily, a thermometer has been devised with a direct-reading degree-day scale added. (See Fig. 1)

Careful study of prevailing data has disclosed that at a certain time each day, the temperature, except on rare occasions, closely approximates the 24-hr. average —without question, sufficiently close for the practical purpose of the fuel business in a customer's follow-up delivery system or for other related purposes.

Daily temperature, when plotted hourly, forms a fairly smooth curve, and this occurs regardless of the general weather level—winter or summer. Obviously, around noon the temperature is above the 24-hr. average and during the late night or early morning, it is below; therefore, except on infrequent occasions, the 24-hr. mean or *average* line intersects the hourly curve on its downward course and again on its upward swing.

†Weston Dodson & Co., Inc., Bethlehem, Pa.

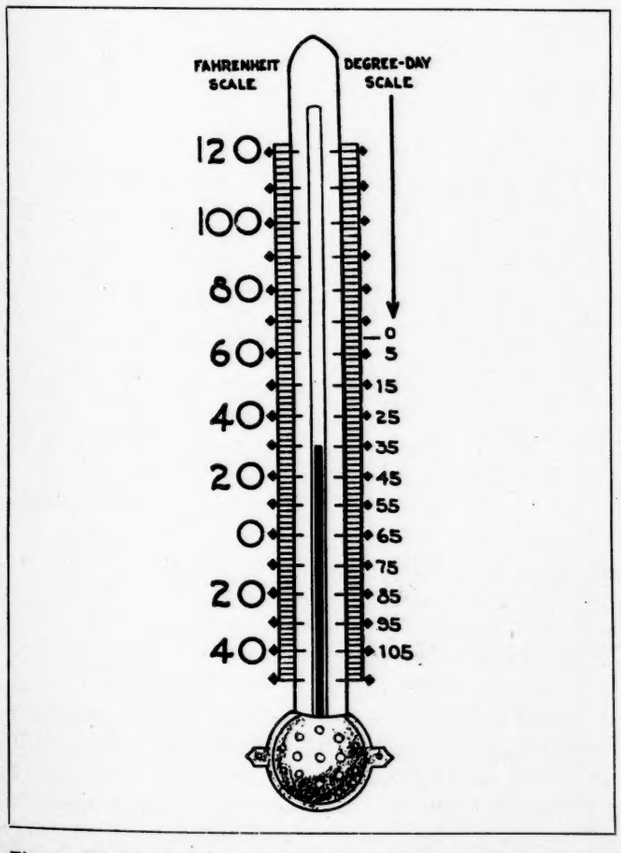


Fig. 1. The degree-day thermometer in which a degree-day scale is placed opposite the usual Fahrenheit scale. Note that zero on the degree-day scale is opposite 65 on the Fahrenheit scale. As the reading on the Fahrenheit scale drops, the number of indicated degree-days increases.

TABLE 1

City	A.M. Hour	Degree-Days July, 1937—July, 1938			Maximum Cumulative Difference End of Any Month
		Per A.M. Hour	Per Mean	Difference	
Washington	10:15	4309	4263	+ 46	62
Philadelphia	10:00	4692	4672	+ 20	42
New York	10:00	5005	4982	+ 23	51
Boston	9:30	5921	5955	— 34	44
Buffalo	10:00	6712	6728	— 16	80
Pittsburgh	9:15	5658	5628	+ 30	73
Detroit	9:45	6409	6404	+ 5	51
Chicago	9:45	6040	6014	+ 26	47
St. Louis	10:45	4370	4374	— 4	60

It has been found that it does so surprisingly close to a certain morning hour, but less closely to an afternoon hour, every day. This morning hour varies somewhat with latitude, and with proximity to large bodies of water. After studying the facts, we have concluded that a morning hour can now be set for at least some localities when the temperature and degree-days for the 24-hr. period can be directly read from the degree-day thermometer.

For five main anthracite consuming areas, this established time is as follows:

Washington	10:15	a.m.	Standard	Time
Philadelphia	10:00	"	"	"
New York	10:00	"	"	"
Boston	9:30	"	"	"
Buffalo	10:00	"	"	"

For a number of smaller cities within these areas, the time also has been set and this in many of the cases coincides with that of the nearest large city.

Time has also been set for the following centers outside of the general anthracite area:

Pittsburgh	9:15	a.m.	Standard	Time
Detroit	9:45	"	"	"
Chicago	9:45	"	"	"
St. Louis	10:45	"	"	"

Work is progressing on other communities so that eventually we expect to have the entire degree-day area of the United States pretty well covered.

Table 1 shows the difference between the degree-days as determined from the fixed morning hour records of the weather bureau and as determined from the daily official weather bureau mean for a full year. In cases where the designated time is not an even hour, the figures were interpolated for the nearest quarter or half-hour.

Similar data for the current year, July, 1938 to July, 1939, are being tabulated and check the above results. For example, New York City degree-days to the end of January, 1939 are 2672 on the daily mean basis and 2699 on the 10:00 a.m. basis.

Our attention was directed to this subject by the increasing interest in the relation of degree-days to the fuel business, and the necessity of finding a simpler way to determine the facts, especially for those situated at a distance from a weather bureau station. That hourly average temperatures for a day might have a definite uniform relationship to the mean suggested itself to me from an entirely unrelated study of cycles.

We found that apparently no comprehensive statistical research had been undertaken by the weather bureau on this specific subject, but the necessary basic records were available. A tabulation was furnished us showing for a number of cities the mean annual temperature and the morning mean hourly averages most nearly approximating the mean for the period 1891-1895. (See Table 2)

This table disclosed the general fact that over the 12 months of this 5-year period, the temperature readings taken around 9:00 or 10:00 a.m. in the anthracite-consuming territory closely approximated the mean.

To determine that no marked monthly variations exist from this annual trend, records of the 24-hr. average temperature and the temperatures at 9:00, 10:00, and 11:00 a.m., by months, for the several cities were examined. The study satisfied us that there was no radical monthly variation from the annual trend.

As one further check, we took the record for the month of January, 1938 and 1939, by days, at New York City, and show in Table 3 the hourly average, the mean of the maximum and minimum, and the 10:00 a.m. figure. While there are varying daily differences, it will be noted that for the entire month, the three sets of figures are almost exactly alike. The difference in one day is very often picked up in the next day, and in groups of three days, there is very little variation.

We recognize for accuracy nothing can take the place of the hourly averages—even the mean obtained from the maximum and minimum differs from it. But we believe that direct readings taken from the Degree-Day Thermometer at the times indicated will be near enough to the Weather Bureau figures to be acceptable for the purpose required by the fuel industry—considerably saving in time and detail.

Several important facts must not be overlooked in this connection, however, and allowance made, otherwise such degree-day readings may appear to be entirely out of line with published Weather Bureau data:

1. The thermometer must be properly placed, in the *shade;* a northern exposure is preferable so that it will have a minimum of radiated heat from nearby materials.

2. Remember that the temperature shown will be that of the air immediately around the bulb. This may vary as much as 5F from the Weather Bureau location, if there is one in your city.

3. In reading a thermometer, the eye should be level with the quicksilver; if read from below, the reading will be "high," and if read from above, too low.

4. Do not condemn a thermometer because it does not agree with one hung near it. These instruments indicate the temperature of the air which surrounds them, and not that of one even 12 in. away.

5. Take care in noting the divisions on the scale. Some thermometers have 1° divisions; others have 2° divisions.

While this method and thermometer are designed for application to the fuel business, the principle could be used in any business requiring average daily temperatures. The ice business, for example, might find it time- and labor-saving to determine its temperature excess in this manner.

TABLE 2—MEAN TEMPERATURES 1891-1895, U. S. WEATHER BUREAU

City	Annual	Hourly	
		9 A.M.	10 A.M.
Washington	54.5	53.1	55.3
Philadelphia	53.4	51.8	53.6
New York	52.0		51.9
Boston	49.2	48.9	50.4
Buffalo	47.7	46.9	48.0
Pittsburgh	53.1		53.0
Detroit	48.0	48.0	49.7
Chicago	47.7	47.1	48.1
St. Louis	55.7	53.6	55.7

TABLE 3—NEW YORK CITY DAILY TEMPERATURES FOR JANUARY, 1938 AND 1939
(From Weather Bureau Records)

Date	January, 1938			January, 1939		
	Average of 24 Hourly Readings	Mean of High & Low	10:00 A.M.	Average of 24 Hourly Readings	Mean of High & Low	10:00 A.M.
1	33	33	32	37	38	32
2	36	38	36	45	44	48
3	32	34	30	37	36	25
4	33	32	36	34	34	31
5	39	38	38	42	42	40
6	43	42	44	48	50	47
7	47	48	45	44	45	40
8	33	34	31	40	42	46
9	25	24	22	42	42	40
10	26	26	28	48	48	43
11	29	29	30	44	44	44
12	32	30	31	34	33	35
13	33	33	36	30	30	29
14	32	32	32	27	26	25
15	25	24	26	27	29	25
16	26	26	23	31	32	27
17	30	28	36	33	35	32
18	12	12	10	29	28	29
19	19	18	11	23	24	21
20	30	32	27	22	23	20
21	34	35	34	29	28	29
22	36	35	37	33	28	40
23	39	39	39	17	18	16
24	43	44	41	32	30	36
25	47	45	55	23	23	27
26	26	26	26	12	13	11
27	22	22	22	16	16	10
28	19	20	18	27	26	27
29	28	28	27	34	36	34
30	47	46	40	35	35	39
31	41	40	51	23	24	23
Degree-Days for the Month	1028	1022	1021	1017	1013	1034

Physiology for the Air Conditioning Engineer

By DR. HOWARD W. HAGGARD†

At the annual meeting of the ASME in New York, December 5-9, 1938, Doctor Haggard presented, under the title "Physiology for the Engineer", the Tenth Robert Henry Thurston lecture, from which this article is abstracted.

I ASK you to follow with me for a few minutes into a subject much to the front today—that of air conditioning. The state of the surrounding atmosphere is well recognized as one of the working and living conditions of primary importance to the well-being of men.

First in this problem I block out familiar boundaries. It is now thoroughly recognized that "bad air" so-called, with its depressing effects on bodily activity, does not acquire its badness from any change in chemical composition. The body has a toleration to variations in oxygen and carbon-dioxide content far beyond any that would occur under conditions of the most extreme bad ventilation. People live in comfort and perform their activities efficiently in Denver, Colorado, where the normal partial pressure of oxygen corresponds to 16% of oxygen at sea level—nearly 5% below that in this room. Carbon dioxide is no longer considered a poisonous waste; there is nearly 6% of this gas at all times in the air of the lungs. The old conception of a poisonous effluvia given off from the lungs and from the human skin has now been relegated wholly to the field of cosmetics and finds its place in the commercial exploitation of mouth washes and deodorizing soaps. In short, we all accept the statement that the effects of poorly conditioned air are not respiratory but cutaneous. Bad ventilation acts upon the temperature-regulating system of the body.

The temperature-regulating system brings us at once to a broad principle of physiology; it is the principle of vital constants. We speak of the conditions in the interior of the body as the internal environment. The internal environment is, during health, kept in a state of amazing uniformity. The range of conditions which the living and active cells of the body can tolerate is extremely narrow. A slight change in alkalinity, in salt concentration, in chemical composition, or temperature, may have a profound influence upon cellular activity, may even stop it and so end the phenomena called life. To maintain this uniformity of internal environment the body has elaborate regulating mechanisms.

Next, the body has about it an external environment —a highly variable external environment to which the body must make continual adjustments through its regulating mechanisms in order to maintain the indispensable constancy of internal environment. In making these adjustments the body expends from its capabilities. To exemplify what I mean and at the same time to anticipate what I shall talk about, there is this situation: In very hot and moist surroundings bodily functions are so engaged in maintaining a uniform body temperature that these functions have little capability left for other performances. Regulation is not carried out by some simple mechanism; it comprises all bodily functions and involves their activities. It does not take a physiologist to tell an engineer that hot surroundings make the performance of a task difficult or impossible.

The heat to keep the body warm is developed in the active tissues, mainly the muscles, and, as you know, a muscle always during life, even in rest, is slightly tense; this tenseness necessitates the liberation of energy as heat. The amount of heat produced in a man relaxed and warm in bed is regulated by another system, which I shall not discuss, to a constant minimum basic evolution of some 160 B.t.u. per hr. per sq. yd. of skin surface. A man of average size has about two yards of skin. From this low level, heat production may rise during muscular exercise to 20, 30, even 40 times the resting rate.

Some 80% of the heat dissipated from the body goes out through the skin but most of it is not directly conducted to the surface from the underlying tissues. The heat is brought to the skin by the blood. The amount of blood flowing through the skin determines the temperature of the skin and hence the heat loss. The size of the blood vessels in the skin is controlled by the nervous system; there are impulses which cause the muscles in the walls of the vessels to relax and so permit enlargement; other impulses constrict and so lessen the size of the vessels. These impulses in turn flow out from a heat-regulating center in the brain—an engineer would call it a thermostat, and, I suspect, begin to make analogies. The secretion of sweat is similarly under nervous control. When the temperature of the blood rises a fraction of a degree the vessels in the skin increase in size and more sweat is secreted. When it falls, the vessels constrict and sweating is diminished. All this is simple and straightforward.

But now we come to the first complicating factor in the coordination of bodily functions. When the vessels of the skin expand, the resistance to the flow of blood is diminished, since by dilatation of the vessels in the skin the channel for the flow of the fluid is increased. The pressure, therefore, tends to fall and it in turn must be regulated, for here, within limits, is another vital constant. To hold up the pressure, arteries are constricted in parts of the body other than the skin, a compensatory constriction mainly in the digestive organs. Consequently digestion may be slowed; in extreme cases it is stopped. To help hold up the pressure of the blood diverted to the enormous channels in the skin, the heart must pump a greater volume for the circulation. In hot surroundings the heart in a man at rest may be doing as much work as it would in the same man performing violent exertion in cool surroundings. You have noticed the deaths, during the heat waves, of invalids with damaged hearts. Heat to them is the same as the exertion which they are incapable of making. It correspondingly limits the capabilities of

†Laboratory of Applied Physiology, Yale University, New Haven, Conn.

the man with the normal heart.

All this arrangement for losing heat that I have described is known in my field as the physical regulation of body temperature. There is a second controlling mechanism; this one is not physical but chemical. It adapts man not to heat but to cold. In cold surroundings even when the heat losses are brought to the lowest possible amounts, when the vessels of the skin are shut down to the utmost and the secretion of sweat is at a minimum, the heat produced in the body at rest may not be sufficient to maintain the normal temperature. The skin becomes uncomfortably cold. The temperature we feel is never that of the interior of the body but only that of the skin. In the cold skin nervous impulses arise and are retransmitted from the spinal cord and brain to the muscles. The muscles grow tense, burning more food and so producing more heat; if tenseness alone fails to give the needed heat, the muscles contract and relax rapidly, the condition known as shivering. At the same time the muscles attached to each hair pull in an effort—an abortive one—to make it stand erect, thus as in other animals to expand and enmesh a greater layer of still air about the body. The best that a human being can do in this respect is to develop goose-pimples.

Now in all I have said, I have made a good case for air conditioning. Any air conditioning, dating back as it does to the first savage who built a fire in his cave or fanned himself with a leaf, now takes on new and vast importance at the hands of the modern engineer. I see, as the engineer sees, the great advantages of comfort and of conservation of capabilities that may be thus directed to productive work. But I see also a drawback in the refinements of air conditioning. From my brief story of temperature regulation it would seem to be evident that the more nearly the cooling powers of the external environment can be brought to the optimum for free heat loss and comfort, the less effort is needed by the regulating mechanism of temperature control in maintaining a uniform internal environment. Simple, clear, and advantageous. But here we come to the danger of simplicity. The engineer is, in matters of development, a man of great refinement; if in the room a temperature variation of 5F can be achieved, why not one of 2F, why not, with refinement of control, make it a fraction of a degree? Fine in principle, fine in selling talk, but disastrous in physiological practice.

The body responds only to stimulation. When stimulation is removed, stagnation results and the human machine does what the inanimate machine never does —it goes to sleep. Continual activity is the penalty for life. When a machine is stopped it does not deteriorate functionally, but the body does. Tie an arm across the chest, keep it stationary, and the muscles shrink and lose their strength. Man has never, until the engineer came on the scene, met an external environment in which the cooling powers of the air were held constant. For the man who is exercising, such constancy is not detrimental, for in him the rate of heat production is variable and the heat-controlling mechanism is kept active even when the external temperature is uniform. But let a man at rest stay in such air and his heat-controlling mechanism also comes to rest; I should like to say it goes to sleep. The invigorating pleasant sensations experienced on a brisk fall day are due to the tensing and relaxing of the muscles as the cool air strikes first one area of the skin and then another. It is a sort of continual massage.

The temperature-regulating mechanism of the body at rest operates best when there are slight but definite and continual changes in the cooling power of the air. The maintenance of too-uniform air conditions relaxes the muscles—takes away this stimulating property of irregular cooling. It relaxes too, as I have said, the temperature-regulating mechanism—makes it for a time sluggish so that it does not then respond well to the severe and abrupt changes experienced in going out of doors from the air conditioned room. As a result of this slowed response there may be an exaggerated sense of heat; there may be changes in many functions such as blood pressure; and there may be annoying nervous disturbances. What, in this rather elaborate way, I have been trying to point out is that temperature regulation of the body is a part of the living system. Its vital peculiarities cannot be ridden over roughshod by the engineer; they must be deferred to.

I have not dealt with the bracing effects of unequally applied radiant heat or the influence of air conditioning on the prevalence of infectious diseases about which again, in spite of much talk and a few inconclusive experiments, no one has any sound knowledge. But we can be sure of this: You cannot take the facts of climatology and apply them to an air-conditioned room. Because there are few head colds in Tucson, Arizona, and little scarlet fever in the tip of Florida means nothing in air conditioning, for here it is not man but another living organism that is concerned. The living organism in this case is the parasite that causes disease. It too has its limitations to external environments. It is not warm weather acting on man that keeps him free from colds and scarlet fever; or cold weather acting on him that keeps him free from yellow fever. Weather does not cause disease, except sunburn, sunstroke, heat collapse, and frostbite. Most diseases—even the common cold—are due to infections, and it is the parasite that has its climatic preferences. Until the engineer can air condition all outdoors his efforts will have little effect on the occurrence of infectious diseases. And if and when he does condition climate he will not do away with infections but only with the seasonal variations in the kinds of diseases. Perhaps in the modern, tight, air conditioned room where air movement is slight as compared to that in the drafty houses with their fireplaces in which our grandfathers lived, the spread of infection is actually increased.

Sometimes in my more Spartan moments I have the passing thought that the engineer may be undermining our national constitution—human constitution—by taking away the hardening influence that our pioneer ancestors knew. I have visions of my grandfather rising in the morning, breaking the ice on the water pitcher, chopping wood for the kitchen stove and fireplace, leading a vigorous, rugged life. And then when I have thoughts of our own cultivated, nurtured decadence with the body made soft and flabby at the hands of the luxuries of engineering, I admire our ancestors—but I thank God for the engineer and his automatic heating and air conditioning.

EDITORIALS

Testing the Performance of Small House Equipment

Latest news regarding the small house testing program at the Bureau of Standards is that a small test house is to be constructed on the grounds and that equipment is to be tried out in an actual building. With the large interest which the government has in the small house because of the financial commitments of past years and because of the social problem connected with small house construction, it was probably inevitable that a study and testing program would have to be a part of the government activities. It is well that this aspect of the problem has been turned over to the Bureau where the test facilities and staff are of the best. There is certainly much to be learned about the equipment which goes into small houses and much more to be learned about how it operates after installation. Studies in a test house can not supply all the information desired but they can be very valuable and can frequently show up the principal points in a much shorter time than is required when the results have to be gained from the field. Adequate test facilities at the Bureau ought to be welcomed by all who are trying to develop equipment suitable for the small house. Central heating equipment for the low cost small house has had a lot of development talent devoted to it in the past few years but has had only little opportunity to prove itself. A testing program should help to gain operating results reasonably quickly.

◆

Cooperation as a Solution

Whether private industry can solve problems to advantage without undue government pressure is a question which has been argued and debated with much spirit in the past few years. Some have held that nothing short of positive public control will accomplish results while others have held equally strong views that private industry can be depended on to solve its own problems with no government pressure whatever. Recently we have seen two examples of how cooperative methods can be used to advantage.

In the one case a public lending agency felt that poor installation was such a menace that its interests were being jeopardized. It took the initiative in calling this state of affairs to the attention of the affected equipment makers with the suggestion that some means be found to insure better installations. The problem was complicated by the fact that there was divided responsibility for the performance of various pieces of equipment, and that a number of groups had to be approached. In spite of this the several groups went to work and a cooperative effort toward a solution has already produced some concrete results.

In the other case there was much difference of opinion and much variation in practice as to the combustion space necessary to allow when underfeed stokers are installed. Here the initiative was taken by the industry itself. A program was laid out whereby various interested trade groups were to work together to produce evidence whereon it is hoped that a reasonable and uniform practice can be built. This program is now in process of being carried out.

To be sure both of these cases involved more or less technical engineering problems, but the point is that if technical problems of considerable public interest can be studied, and perhaps solved, by technicians getting together cooperatively there is every reason to believe that other, and non-technical, problems could be approached to good advantage by similar methods.

Here and there this method is being used and its general application holds much promise as a means of avoiding direct government control. It is a more or less middle-of-the-road course between the extreme views of those who advocate a full hands-off policy and those who believe in full public control. It would be well for all of us to keep in mind that a policy of this kind is rather likely to come into increasing favor as time goes on.

◆

The Present Day Apartment

More new apartment houses, built with both private and public funds, are either under construction now or are expected to be built this year than in any other year since the late twenties. These new apartment houses are a far cry from those which were put up as speculation during the boom period. Then the idea frequently was to get them thrown together some way, get them filled with tenants and then to unload them on some unsuspecting purchaser. There is still too much of this same thought to be sure, but now there is a much greater tendency to construct buildings as a permanent investment and to regard them as such when proposals for their heating are under consideration. Now, too, there is much better experience on which to draw, a record of past mistakes to be avoided, and an infinitely greater variety of equipment and method available than was at hand fifteen years ago. There is a tendency to buy closely and so far as possible on performance, but there is also a tendency to examine the problem as a whole and to sanction automatic control, to consider tenant convenience and comfort, and to permit the heating plant to be adequate in both capacity and quality. The apartment house work is now worth going after to a much greater extent than has been the case for a long period.

ABSTRACTS of Current Papers, Books and Pamphlets

Engineers' Manual

The purpose of this book is to make available in one volume formulas and constants which the engineer uses from time to time. The author felt that not only would this result in a considerable saving of time to the engineer but also that it would make possible a more concise explanation of the application of each formula than could be made in the usual textbook.

Many changes have been incorporated in this, the second edition. For example, the entire chapter on heat and a large part of the chapter on electricity have been rewritten and brought up to date. This edition also contains revisions and extensions of all tables of physical constants, new steam tables and recomputations of all conversion factors affected by the latest definition of the British Thermal Unit and an enlarged table of conversion factors. Among the subjects covered by the book are: mathematics, mechanics, heat, electricity, mathematical tables and physical tables.

[*"The Engineers' Manual," by Ralph G. Hudson, second edition. Published by John Wiley & Sons, Inc., New York. Flexible binding; 5 x 8 in.; 340 pages; price, $2.75.*]

●

Fan Engineering

The fourth edition of "Fan Engineering," like previous editions, has been prepared to fulfill the need for a handbook dealing with fans and various fan applications. The present edition has 120 pages more than the third edition and all sections except those dealing with the basic laws have been extensively revised. The general style of previous editions has been retained.

New data are contained principally under the following headings: Properties of Air; Heat and Humidity; Flow of Fluids in General; Air Conditioning; Combustion; Drying; Dust Elimination; Exhausting and Conveying. A new section is devoted to power equipment, fan details, typical problems, and selection of apparatus.

[*"Fan Engineering," 4th Edition, by Richard D. Madison; published by Buffalo Forge Co., Buffalo, N. Y. Flexible binding; 4¼ x 7 in.; 740 pages; price, $4.*]

●

Chemical Dehumidification

Air conditioning installations may be grouped generally into (1) those in which comfort conditions are to be maintained, and (2) those used for industrial or technical operations. In both cases for summer operation it is invariably necessary to remove moisture from the air.

Considerable attention has been focused lately on chemical dehumidification which offers a means of controlling relative humidity at a cost that is very much less than is possible with refrigeration.

The present trend in liquid chemical dehumidification is towards the use of various chlorides in water solutions which are held at some predetermined concentration. Chemical dehumidifiers can be divided into three general classes, as follows: (1) the adiabatic dehumidifier; (2) the isothermal dehumidifier and (3) the Calorider dehumidifier.

In the adiabatic dehumidifier, hygroscopic brine is sprayed into a chamber through which the air being treated is passing and the brine absorbs water vapor from the air stream. There is no change in total heat in an adiabatic unit, so the dry bulb temperature of the air rises as the dewpoint lowers with the absorption of moisture by the brine.

Liquid chemical dehumidifiers of the adiabatic type produce the same results as are obtained by the use of silica gel and activated alumina without interstage cooling, for these solid absorbent units are adiabatic.

The isothermal dehumidifier is really a modified adiabatic unit in which the latent heat of the moisture removed from the air is taken up by the brine solution which is cooled sufficiently by external means to produce this result, that is, keeping the air at constant dry bulb temperature through the unit.

In the Calorider type of dehumidifier the hygroscopic brine is sprayed over extended surface cooling coils so that the air and brine is progressively cooled as it passes through the unit. The unit is so designed that air will leave the Calorider within 5F of the cooling water supply temperature.

[*"Air Conditioning Featuring Chemical Dehumidification," by Stewart C. Coey. Paper presented before 34th annual meeting, ASRE, December 7, 1938.*]

●

Refrigerating Data Book

The fourth edition of the Refrigerating Data Book has been practically completely rewritten, having some 34 new chapters out of a total of 50. It follows the same general form as previous editions and is divided into eight principal sections. These sections are entitled: Principles; Refrigerants; Heat Flow and Insulation; Air Conditioning; Foods; Domestic and Commercial Machinery; Industrial Machinery; Control and Power.

Previous editions of this book have appeared every two years. The next edition, however, is not expected to appear for four years as work is now under way on a second volume which will cover applications of refrigeration. This will be a thoroughly new work and will deal with the many uses of refrigeration in industry, food preservation, air conditioning, and elsewhere.

A new feature of the present edition is the inclusion, at the end of a number of chapters, of specification tables, giving the dimensions, capacities and other facts on the existing equipment. These are included to save the reader a lengthy search through trade literature.

[*"Refrigerating Data Book." Published by American Society of Refrigerating Engineers, New York. Cloth binding; 6½ x 9½ in.; 527 pages in technical section; refrigerating catalog and list of members included. Price, $4 per copy in United States, $4.50 elsewhere.*]

Domestic Hot Water Supply Piping

Considerable improvement in the domestic hot water service may be obtained by careful design and layout of piping, although this fact is not generally recognized. A comparison of water temperature variations in laboratory heater tests with those obtained at the faucet in a typical home installation demonstrated that a weakness of some systems existed in the design of the piping.

Each time hot water is drawn from a faucet a certain amount of hot water is left in the house piping. After the faucet is turned off, the water left in the piping starts to cool, rapidly at first and then more slowly, until it reaches room temperature or until the faucet is again turned on for additional use. In addition to the heat loss due to water cooling in the pipes, there is also a waste of water.

There are three methods available for the reduction of piping losses in the house piping system. The first method involves the use of an insulating covering which keeps the piping hot and reduces the temperature loss in the spring.

The magnitude of the piping loss also depends on the amount of hot water stored in the piping. This leads to a second method of reducing the loss, namely, the use of small-sized rigid pipe or semi-rigid tubing. A saving is obtained even though the water cools in the pipes, for since the amount stored is so small compared to that contained in conventional piping, the heat loss is greatly reduced.

The third method of reducing pipe line losses is accomplished by reducing the length of pipe from the water heater to the principal house faucets.

From tests conducted by the author on the water system of a six-room house it was concluded that for a water consumption of 40 gal. per day, the saving in heat loss from the piping is 12% through the use of 1 in. of insulation on the piping, and 26% through the use of small-sized pipe and tubing. This saving is expressed as a percentage of the total heat supplied in the hot water used.

For a water consumption of 50 gal. per day, the savings are 14.5% for insulation and 24% for small-sized pipe and tubing.

For a water consumption of 60 gal. per day, the savings are 15% for insulation and 21% for small-sized pipe and tubing.

It was found that hot water was used more times per day when insulation and small-sized tubing were installed, although the total water consumption did not increase. The reduction of the heat loss from the piping is an explanation for the fact that the water consumption did not increase. The improved hot water service at the faucet or the greater availability of hot water throughout the day is an explanation for the increased number of times water was used. Apparently water was used more often for various purposes or more uses were found for it in this home after improvements in the piping were made.

[*"Improved Hot Water Supply Piping," by J. M. Krappe, Research Series No. 64, Engineering Bulletin. Published by Engineering Experiment Station, Purdue University, Lafayette, Ind. Heavy paper cover; 6 x 9 in.; 28 pages; price, 25 cents. A limited number of copies are available without charge.*]

BRIEF REVIEWS

SMOKE ABATEMENT. Takes up the work of the National Smoke Abatement Society and consolidates the provisions of smoke nuisances. There are nine chapters headed as follows: History; The Common Law; Private Houses; Trade Premises; London; Shipping; Railways; Vehicles and Joint Action. [*"The Law of Smoke Nuisances," by W. R. Hornby Steer. Published by the National Smoke Abatement Society, Chandos House, Buckingham Gate, Westminster, S.W. 1, England. 65 pages; size 6 x 8 in.*]

NOISE. A report by the American Medical Association's Committee on Air Conditioning, reviewing the present concepts of noise and its relation to comfort and health of human beings. [*"Noise and Its Effect on Human Beings," by C. P. McCord, E. E. Teal, and W. N. Witheridge. Published by The Journal of the American Medical Association, May 7, 1938, Vol. 110, pages 1553-1560.*]

DISTRICT HEATING. Proceedings of the 29th annual convention of the National District Heating Association held in Baltimore, Md., June 28 to July 1, 1938. Includes lists of committees, lists of members, proceedings, constitution, and transactions. [*"Official Proceedings of the National District Heating Association," Volume XXIX. Published by the National District Heating Association, 1317 Spruce St., Philadelphia, Pa. Cloth bound; 6 x 9 in.; 328 pages; price, $5.*]

LOW TEMPERATURE REFRIGERATION. A description of the developments in low temperature testing work which have come about due to the need for low temperatures in testing of oils, aviation and automotive products. Paper also describes the equipment used for obtaining temperatures of —40F in four rooms in an oil refinery. [*"Laboratory Aspects of Low Temperature Refrigeration," by A. V. Ritchie, N. H. Hiller, Jr., and A. F. Brewer. Paper presented before the 34th annual meeting of the ASRE, New York, December 7, 1938.*]

REFRIGERATION. An outline of the evolution of the larger type of commercial and industrial compressors. Describes the developments and improvements in both horizontal and vertical compressors. [*"Trends in Modern Refrigeration Compressor Design," by H. C. Guild. Presented before the 34 annual meeting of the ASRE, New York, December 7, 1938.*]

HOUSING. The Division of Social Research of Works Progress Administration has published a summary of the data collected by real property inventories in more than 200 urban areas. These inventories covered more than eight million dwelling units or approximately 45% of the number of urban families in the United States in 1930. In addition to information on type, age, costs, value, and mortgage status of residential structures, information is given on heating and sanitary facilities. [*"Urban Housing—A Summary of Real Property Inventories Conducted As Work Projects, 1934-36," by Peyton Stapp. Size, 7 x 10 in.; 326 pages, lithographed. Obtainable from the United States Government Printing Office, Washington.*]

NEWS OF THE MONTH

National Gallery of Art in Washington to be Air Conditioned; Other Galleries Report Highly Favorable Experiences

WASHINGTON — When the new National Gallery of Art here opens its doors to the public next year one of the world's most valuable collections of Old World masterpieces will go on exhibit in an air conditioned atmosphere. Until now, the most extensive system of museum air conditioning in the country has been in the Frick Museum in New York, endowed by Henry Clay Frick.

Conceived and made possible by the generosity of the late Andrew W. Mellon, the National Gallery of Art has been under construction since 1937 along the Mall, between Fourth and Seventh Streets. The architect for the building, John Russell Pope, sketched the roofline to harmonize with the Capitol, the United States Museum across the Mall, and other nearby buildings.

The National Gallery is the culmination of a life-long dream of Mr. Mellon's for an American institution comparable to the Louvre of Paris, the Vatican and Renaissance palaces of Italy, the National Art Gallery of England, and the Kaiser Friedrich Museum of Berlin.

Before his death in 1937, Mr. Mellon offered to erect the building and donate his own private art collection, now valued at $50 million, as the nucleus for a national collection to which other wealthy art lovers might contribute. The offer was accepted by a Congressional resolution.

The Mellon collection of Old World masterpieces includes all the important schools of Western European painting. Among the Italian works are famous pieces by Raphael, Perugino, Botticelli and others. The Flemish school is represented by Jan van Eyck, Rogier van der Weyden and others. From the Dutch school are paintings by Frans Hals, while the Spanish masters are represented by works of El Greco, Goya, and Velasquez.

At the headquarters of the Air Conditioning Manufacturers' Association in Washington, William B. Henderson, executive vice-president, pointed out that air conditioning has dual benefits to an art gallery or museum. First and most obvious is the comfort it provides the staff and the visiting public. But even more important to such an institution is the preservative effect of uniform temperatures and humidities on irreplaceable objets d'art.

Deterioration of art possessions under varying humidities and temperatures, such as we have in this country, is one of the chief concerns of art directors.

The low humidities prevailing in the winter months cause parchment, paint, wood, and textiles to become brittle and crack. On the other hand, when humidities are excessive in summer, the growth of molds, fungus, and mildew is stimulated. And the daily swings of temperature and humidity impose a strain on the structure of tapestries, furniture, and paintings which eventually leads to their destruction.

It has long been a matter of despair to American collectors that climatic conditions here should have so harmful an effect on antiques which have successfully withstood the ravages of centuries in Europe. Antiques from the warm, dry climates, especially, deterioriate rapidly under the wide variances of America's weather conditions.

As an illustration, what is called "bronze disease" by J. Francis McCabe, superintendent of the Art Institute of Chicago, attacks bronze antiques excavated in Greece and Macedonia and, in time, eats away the surface of the metal. Mr. McCabe describes this disease as a fungus growth which apparently can be overcome only by two methods: by the concentrated application of heat rays or by air conditioning. Old armor is affected in much the same way by a rust growth.

At the Frick Museum in New York, which has employed air conditioning for three years, Dr. F. Mortimer Clapp, director, reports that air conditioning has completely eliminated "bloom" from the surface of oil paintings. This bluish film of moisture, which shows up on varnished surfaces in damp weather, not only detracts from the appearance of a painting, but is a signal to art directors that they must not apply any paint or other preservative until the bloom has been removed by a change to drier weather.

Another difficulty which is overcome by air conditioning arises from the fact that most museums are located in the heart of large cities, where the outside atmosphere is heavily laden with dust and sulphurous acid gas from chimneys. Dust is a most destructive agent to all fabrics, while sulphurous acid attacks metals.

In the Frick Museum, Doctor Clapp describes a state of cleanliness which is the envy of all art directors—his attendants do not need to dust off their exhibit pieces more than once a year. And the acid content of New York air is neutralized by operating the conditioning system with a slightly alkaline content in the air washer.

Licensing of A.C. Installers Urged in Bill Introduced in New York

NEW YORK—Identical bills have been introduced into the Senate and Assembly of the New York State Legislature providing for setting up of a state board to license air conditioning contractors and providing for the inspection of air conditioning systems in buildings of all classes within the state.

The bills provide for a state board consisting of five members to be appointed by the governor; one of the members would be a sheet metal worker, another a sheet metal employer, a third a steamfitter, another a steamfitter employer, and the fifth a mechanical engineer selected from a panel of five recommended by the ASHVE. Members of the board would be paid $20 per day for each day's service and the chairman $25 per day.

The bills also provide for a local board in each city of the state, members of which would be appointed by the mayor. These members would receive $15 per day. The state board would prepare and formulate rules and regulations respecting construction, installation, alteration, and maintenance of air conditioning systems and hear appeals from the local boards. The local boards would administer and carry into effect the rules laid down by the state board.

Contractors would be charged a fee of $25 for a certificate of competency and $10 for a renewal each year.

A. V. Hutchinson, secretary of the ASHVE, has notified members that the society does not sponsor this legislation and the use of its name in the bills is unauthorized.

A bill has also been introduced into the New York legislature providing for an amendment to the labor law of the state to include technical employes, such as draftsmen and other engineers working on a salary, bringing them within the scope of the labor law.

Hot Water Discussed at Toronto

TORONTO — Seventy-seven members and guests attended the February meeting of the ASHVE Toronto chapter held in the Royal York Hotel. President Hugh Jenney introduced Harry H. Angus, chairman of the open forum meeting on domestic hot water heating. Mr. Angus outlined data pertaining to domestic hot water heating, and John Fox showed a film of various types of automatic control for such systems.

President Jenney announced that the nominating committee, which was selected by the Board of Governors, is to consist of Harry H. Angus, chairman, W. R. Blackhall, and M. W. Shears.

Heat Machine Proves Successful in Combating Various Diseases, Report of University of Pittsburgh Medical School Shows

PITTSBURGH—Twelve months of research in fever therapy have provided the medical world with an improved weapon not only against syphilis but also St. Vitus dance, rheumatic heart disease, some cases of arthritis, encephalitis, vascular diseases and meningitis. This weapon is a combination of mechanically induced fever treatment and medicinal drugs having "tremendous advantages over any previous form of treatment."

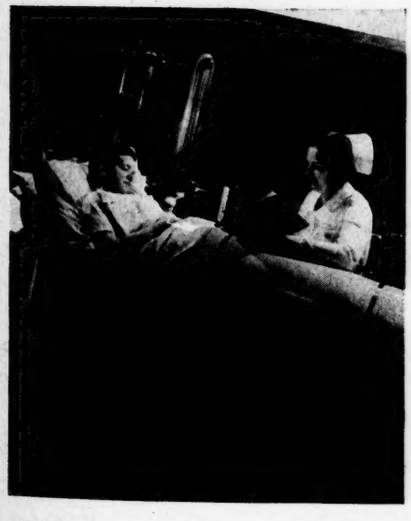
Dr. T. Lyle Hazlett, director of the Department of Industrial Hygiene of the University of Pittsburgh's School of Medicine, and Dr. Murray B. Ferderber, research fellow of the department, made this report today in a summary of the first year's work in a fever therapy research program, made possible by a $50,000 grant to the University by the Westinghouse Electric and Manufacturing Company.

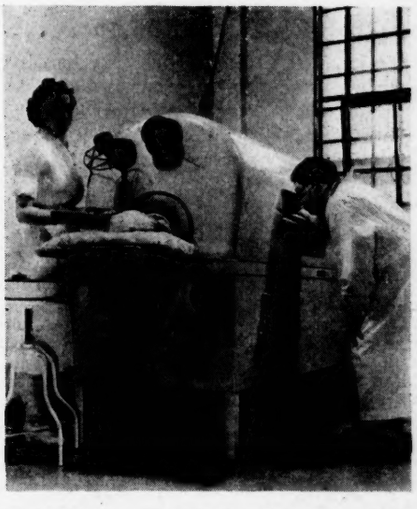
For some 20 years, syphilis has been treated with fever. During part of this time physicians have been using artificial fever machines, but more commonly they have innoculated active malaria, typhoid, or other bacterial products into the patient to produce fever. "With one disease imposed on another for therapeutic purposes," the report states, "it would appear that the welfare of the patient would be jeopardized, since malaria, whether pathologically or clinically induced, has a mortality of its own. The ability to induce a controlled temperature on a physiological basis would appear to be a wiser and safer procedure."

Physicians in six hospitals cooperated in testing this theory. They found that the use of mechanically induced fever not only permits the administration of anti-syphilitic drugs, such as mercury, bismuth and arsenic, while the patient is being treated, but that "this form of combined treatment produces greater absorption of the drugs and more rapid results than the former conventional methods, thus shortening the course of the disease and preventing later complications."

Patients who had shown no improvement under the conventional treatment showed "definite and progressive improvement" from week to week under the combined drug and fever therapy "so that these cases and others to be reported in the future appear to confirm our idea of combined therapy," the report states, cautioning, however, that "it is yet too early to predict the ultimate results in each case."

This artificial fever is built up in a long cylindrical cabinet, which was designed by Doctor Ferderber, F. C. Houghten, research director of the ASHVE, and Carl Gutberlet, research assistant of the ASHVE. It differs from other fever therapy machines in that it uses for the first time air heated and moistened by water to induce an artificial fever within the patient's body. Within the cylinder is a duct and spray system attached to the hot and cold water supply of the hospital and regulated by thermostatically controlled mixing valves which set the temperature of the water. Air is sucked out of one side of the cabinet, completely saturated with the hot water and returned to the cabinet. The first of these machines was installed during November, 1937, in Magee Hospital.





(Left) Fever therapy helped this boy walk after being bedridden for more than a year. (Right) A sliding door in the side of the fever therapy machine enables checking the patient's heart action. An electric fan keeps the patient's face and head cool while saturated warm air inside cabinet raises his temperature to 104F.

Stoker Makers to Meet June 1-2 at French Lick Springs

CHICAGO—At the regular quarterly meeting of the Stoker Manufacturers Association held here February 16, it was voted to hold the 1939 annual convention of the Association at French Lick Springs, Ind., June 1-2. A special committee has been appointed to handle the convention and to prepare a program which will be of interest to stoker manufacturing men, coal operators and allied interests in every section of the country. Further details will be made public at a later date.

Many other routine matters were discussed at the meeting. Of special interest was a symposium of sales problems in the stoker industry in 1939, at which time brief papers were presented by leading sales executives in the industry indicating an optimistic attitude over the prospects for making 1939 a better year than 1938. Many leading manufacturers expect increases ranging from 10% to 20%.

Plans were discussed as to the sales methods which could be promoted to install stokers in more new homes. Concerted efforts on the part of the members of this Association to carry the message of automatic coal heat into every city, town and village in the nation was discussed in great detail and a complete study of this problem is being made by the Association.

During the luncheon the members heard an extemporaneous and highly interesting talk by R. C. Goddard, stoker manufacturer, who recently returned from a two-months' trip in Europe on stoker business. He reported a growing interest in many European countries in American stoker equipment with application to metallurgical and drying installations.

Simpson Speaks on Air Drying

PITTSBURGH—G. L. Simpson, vice-president and general manager of the Pittsburgh Lectrodryer Corp., was the speaker of the evening at the February meeting of the Pittsburgh chapter of the ASHVE February 13. The speaker defined the term water vapor, its characteristics, how it varies from day to day and the ways and means to maintain its rate at a predetermined range.

Various problems arising in dehumidification work were discussed and illustrated through the use of slides. After the question period came to an end a small model dehumidifier was demonstrated which depended upon activated alumina as its absorption medium.

A tentative and proposed ordinance governing the design and installation of ventilating, air conditioning, and warm air systems, was read at the meeting. A committee was appointed to look into the matter further.

Prosperity of Building Industry Depends on Housing Funds, Housing Administrator Straus States in Annual Report

WASHINGTON — One of the greatest mass migrations in history, the removal of more than 500,000 persons from slums into new homes, will soon be under way, according to the first annual report of the United States Housing Authority, submitted to Congress January 31 by Administrator Nathan Straus. By midsummer this year 5,000 families in the lowest income group will be moving every month into new homes and the exodus from blighted urban areas will continue until approximately 165,000 new homes have been provided. In addition to the 9,956 homes now actually being built, it is estimated that during 1939 construction will be started on between 75,000 and 80,000 additional dwellings.

Substantially all USHA funds available for assistance to local housing authorities have already been committed, according to the report. At the present time there are under contract USHA loans totaling $321 million for some 140 low-rent housing projects in 75 communities in 22 states, the District of Columbia, and Hawaii. In addition, 123 communities now have outstanding USHA earmarkings amounting to nearly $329 million.

It is estimated by the report that the work created under USHA's lending program will make possible a total of 270 million man-hours of work at project sites and that more than $257 million will be paid in wages to laborers at the sites, and that approximately 400 million more man-hours of work will be necessary to supply materials.

"In short," the report adds, "the increasing volume of re-employment and construction activity in 1939 and the opening of projects for occupancy in 1940 will result from undertakings commenced with funds made available in 1938.

"By the same token, the Administrator feels in duty bound to point out to Congress that the maintenance of construction activity and employment in 1940, and the opening of additional completed projects in late 1940 and 1941, depend upon a new authorization of funds being made now for the initial undertaking of additional projects. Since the United States Housing Authority now has no additional funds to earmark, there is a certain prospect for a long hiatus in the housing program when the projects now under way are completed unless more funds are now authorized to start new projects. It is equally true that the innumerable cities throughout the country with serious housing conditions which have not yet entered the program, the cities already in the program but merely making a commencement in their attack upon their slum problems, and the cities in the fifteen states that have not yet enacted enabling legislation, are all precluded from initiating or expanding their programs unless more funds are made available.

"In the light of its first year's experience under the United States Housing Act, the Authority," the report continues, "is in a position to demonstrate substantially that all the aims of the Act will be realized and that all its conditions are being successfully met.

"We now know that public housing can be and is being produced as economically as private housing; that rents can be and are being reduced to the point where slum dwellers and the slum dwellers alone will be served, thus avoiding any possibility of competition with decent private housing; that the small amount of outright expenditure (as distinguished from strictly returnable loans) for public housing makes it one of the most economical and at the same time one of the most durable forms of public improvement; that the machinery of the USHA affords a striking illustration of the feasibility of enlisting local capital investment and local expenditures in support of local public improvements; and that Federal financial assistance and the development of sound standards can be combined with local administration and genuine local responsibility.

"It is now a matter of ascertainable fact," it is added, "that public housing can be produced cheaply and brought within the reach of the underprivileged who dwell in the slums; that the actual annual cost of public housing to the Federal Government and to the localities is perhaps lower than for any comparable social and economic improvement; that the public housing program has developed machinery for the progressive investment of local capital in low-rent housing and the progressive assumption of local responsibility for attacking the housing problem; that such a program is enlisting the cooperation of Federal, state and local public agencies, business, banking, labor and all groups interested in social advancement; that perhaps the most needed and durable of all public improvements is being united with reemployment, business stimulation, and the creation of decent living conditions for American families. The need for such a program was evident. The need for continuing and enlarging such a program is no less evident."

The first section of the report places special emphasis on estimated rents to be charged tenants in projects built with USHA assistance, and shows that such rents will be lower than had been anticipated and well within the reach of the low-income families for which the new homes are designed.

In almost every one of the first 14 USHA-aided projects on which main construction contracts have been let, according to the report, the actual costs have been substantially less than the preliminary estimated cost used as a basis of USHA loan contracts. On the average, the actual construction cost of dwellings on these 14 projects is 11.6% less than the preliminary estimates.

The fact that in November, 1937, there were only 46 local housing authorities and that by the end of December, 1938, there were 221 such agencies, is viewed in the report as a sign of "rapid growth of interest in the USHA program and the acceptance of the principle that local authorities are a proper vehicle for the development of public housing."

The report explains that USHA commitments have been made for projects of local housing authorities in only 29 states because enabling housing legislation has been adopted in only 33 states, in several of which the laws need revision. It is noted that the legislatures in each of the 15 states without housing enabling legislation are meeting in 1939 and will have an opportunity to pass upon the question of adopting legislation authorizing those states to participate in the USHA program. The following states do not have housing legislation: Arizona, Idaho, Iowa, Kansas, Maine, Minnesota, Missouri, Nevada, New Hampshire, New Mexico, Oklahoma, South Dakota, Utah, Washington, and Wyoming.

Johnson to Run Chimney Tests

PRIMOS, PA.—Anthracite Industries, Inc., laboratory here will conduct a series of tests on several experimental chimneys for domestic boilers in order to determine some basic facts about chimneys and draft as related to domestic boilers under 1,000 sq. ft. of steam radiation capacity, according to Allen J. Johnson, director of the laboratory.

R. M. Dill, of the National Bureau of Standards, is also carrying on somewhat similar work at the Bureau in connection with boiler ratings. The Institute of Boiler and Radiator Manufacturers is reported to be working on a parallel problem.

Northwest Group Meets in Tacoma

SEATTLE—With C. W. May, president, in the chair, and delegates to the national convention at Pittsburgh reporting, the Pacific Northwest chapter of the ASHVE held its February meeting at the Tacoma Hotel, Tacoma, Wash. Clark Eldridge, state highway engineer of Washington, spoke on The Tacoma Narrows Bridge.

House Building Technics Discussed at Yale-Life Conference; Experimental Low Cost Housing Featured at Meeting

NEW HAVEN—A conference on house building technics with special emphasis on experimental low-cost housing was held here January 31 and February 1 under the sponsorship of Yale University School of the Fine Arts and Life Magazine. The conference attracted a large attendance of leading architects, manufacturers, and building technicians and experts interested in the problem of low-cost housing.

Speakers at general meetings included Everett V. Meeks, Dean, School of the Fine Arts; Wallace K. Harrison, Associate Professor of Architecture; R. H. Shreve, Shreve, Lamb & Harmon, New York; Frederick K. Weyerhaeuser, Weyerhaeuser Sales Co.; Beardsley Ruml, R. H. Macy & Co.; Miles L. Colean, Deputy Administrator, Federal Housing Administration; Ralph T. Walker, Architectural League of New York; George W. Trayer, U. S. Department of Agriculture; Raymond V. Parsons, Johns-Manville Corp.; J. E. Burchard, director, Bemis Foundation, Massachusetts Institute of Technology; R. L. Hanson & L. J. Sivian, Bell Telephone Laboratories; L. A. Estes, Carnegie-Illinois Steel Corp.; Corwin Willson, Engineer and Designer; and Robert L. Davison, John B. Pierce Foundation.

The conference included an address by Dr. C.-E. A. Winslow, Professor of Public Health, Yale University, on "Heating and Ventilation of the House." In his remarks Professor Winslow indicated that so far as he could gather from all existing data the only requirement in connection with heating and ventilation of small houses and living quarters was a provision for reasonably adequate ventilation and for the proper examination of heating from the viewpoint of the occupants. In his opinion there are almost no cases where there are problems of chemical impurities in the air, dusts, or odors, that are likely to be of any particular importance in installations in low-priced houses.

Doctor Winslow also stated that he believed that during the winter season the question of the indoor relative humidity is of no particular importance and that the main thing is to maintain a suitable temperature. In summer, however, he believed that relative humidities might be of considerably greater importance since the body temperature control operates in an essentially different fashion in summer than it does in winter.

A round table conference over which C. George Segeler, American Gas Association, presided, was an additional feature of the conference. It aroused discussion concerning attempts to arrange suitable heating installations in low-cost construction. Those present outlined thoughts and experiences in connection with recent attempts to meet the budget set up by designers in attempting to reach low costs. It was brought out that in some of the recent detached house designs only about $125 is provided for the heating system. In spite of this low figure it was indicated that means are at hand for making heating available for small houses at costs approaching this figure, by adapting existing equipment to the purpose.

The whole conference, which served as a forum for presentation of thoughts and recent practices and experiences, indicates that while a great deal of thought and attention has been given to the small low-cost house and while there is a great variety of materials and equipments available for possible use in such construction, there is still very little agreement regarding just what should be done in detail to meet the necessities of this kind of building.

Unit Heater Group Elects Nesbitt

PITTSBURGH — The Industrial Unit Heater Association at its annual meeting here January 23 elected Albert J. Nesbitt as president; J. F. G. Miller, vice-president; and L. O. Monroe, secretary-treasurer for the ensuing year.

Albert J. Nesbitt

The benefits already derived from the standardization program started two years ago and in effect at present has caused the Association to make studies on the subject of corrosion, maximum operating temperatures, as well as to undertake further standardization of motors.

New U.S. Record for Low Pressure

WASHINGTON—According to the U. S. Department of Agriculture a new all-time low for atmospheric pressure in the western hemisphere was reached during the Long Key hurricane of early September, 1935. A barometer on a small boat which rode out the storm off Craig, Fla., registered 26.35 in. on September 2, 1935. This is just a little higher than the world's low record, 26.185 in., reported by a Dutch steamship in the Pacific 460 miles east of Luzon, August 18, 1927. As no barometer in the Americas had ever before fallen below 27 in. the Weather Bureau checked and rechecked the privately owned aneroid barometer that gave the new low reading before accepting the record.

Test House for Heating Planned by Bureau of Standards

WASHINGTON—Plans for construction, on the spacious grounds of the National Bureau of Standards, of an FHA-designed small home to serve as a testing station for heating units designed for small houses, were announced late in February by Dr. H. L. Dryden, chief of the division of mechanics and sound, Bureau of Standards.

Erection of the test home was authorized February 18 and necessary funds for construction work await conferences in which officials of the government housing bureaus and the Bureau of Standards will select a suitable design.

"To supplement laboratory tests of various types of heating equipment, it has been deemed advisable to observe the operation of several of the smaller types of heating units under actual housing conditions," Doctor Dryden said. "While the house plan to be used has not been definitely decided upon, it will probably be typical of minimum homes permitted under FHA requirements.

"The test house will be used to observe small circulating warm air plants, heatilator fireplace units, and similar installations. When construction is completed manufacturers will be invited to submit plans for observation.

"While results of tests made by the Bureau of Standards cannot be used for advertising purposes, units so tested are in line for intelligent consideration when government purchases are involved. Besides indirectly verifying manufacturers' claims, tests conducted by the bureau are intended to indicate how and under what conditions a product is most efficient.

"Thus certain differences in the rated capacity of heating units would not imply that one is inferior to another, any more than it would obtain that an 8-qt. pail is less efficient than one of 10-qt. capacity. Each serves its purpose and our task is to accumulate information needed to determine the proper application."

Predicts 300 A.C. Buses by Summer

DETROIT—More air conditioned buses were predicted at the annual meeting of the Society of Automotive Engineers here recently.

R. E. Gould, of the General Motors refrigeration division, showed that air conditioning had passed beyond the stage of public acceptance to that of public demand in many types of public buildings and some forms of mobile equipment such as railroad passenger cars.

He predicted that 300 to 400 fully air conditioned buses would be on the highways next summer.

Reverse Refrigeration Cycle Job Installed on West Coast to Cool and Heat Small Office Building

EMERYVILLE, CALIF. — Automatically holding 70F regardless of outside temperature, the reverse cycle air conditioning system installed in the new Westinghouse building here heats or cools, corrects humidity, and circulates 16,000 c.f.m. The estimated cooling is 196,000 B.t.u. and the estimated heating is 238,400 B.t.u. with outside temperature of 35F and inside temperature of 70F.

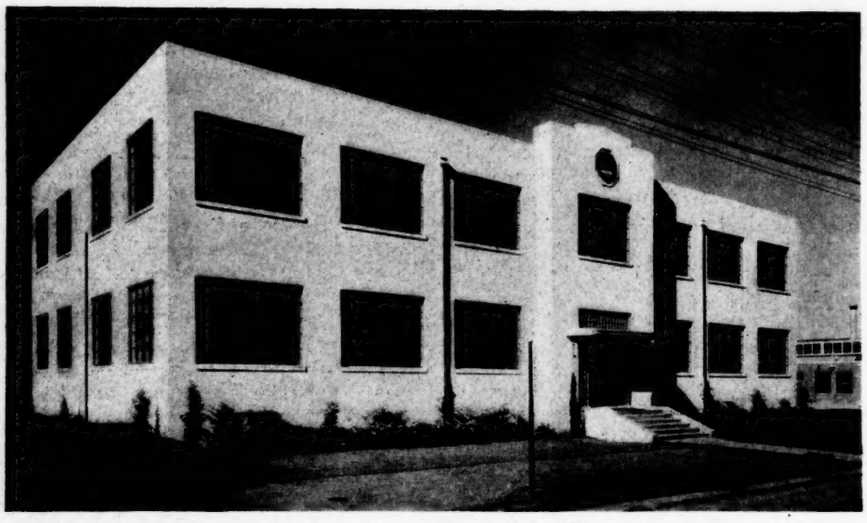
The building completely conditioned by the plant is 90 ft. long, 50 ft. wide, two stories high, with 6-in. concrete walls and roof insulated with 4-in. redwood bark.

For heating, the capital investment is comparable to that of a conventional system. At one cent per kilowatt-hour the cost of heating the building with this system based on electrical energy is comparable to a natural gas or oil fired system. The pick-up ratio of the heat pump installation with an outdoor temperature of 35F and a room temperature of 70F is approximately five to one. In other words, for every kilowatt-hour or electrical energy consumed, the equivalent of approximately five kilowatt-hours of heat energy is obtained.

This plant, which takes two 7½-ton, hermetically-sealed compressors, has been designed for manual or full automatic operation, with necessary thermostats, humidstats, and protective devices to maintain constant temperature, air circulation, air filtration, and humidity control for summer and winter conditioning. A 7½-hp. motor operates each compressor, and each fan is operated by a 3-hp. motor, making a total connected load of 21 hp.

The system is known as a central plant type, with all air conditioning apparatus in one room. The conditioned air is forced through ducts to the two floors and individual rooms by fans. In the air conditioning room is a set of dampers for controlling the volume of air to the two floors, and at each outlet is a control for individual adjustment. A total of 8000 cu. ft. of air is drawn into the building each minute, and is mixed with an equal amount of circulated air.

Air circulated throughout the building is cooled by mechanical refrigeration during the summer cooling cycle, and by means of automatic controls the same equipment supplies heated air during winter conditions. The air conditioning unit consists of two sections, each section equipped with fans for circulating air. One fan discharges used air to the outdoors, and the second fan discharges the fresh air into the building.



A Westinghouse reverse cycle air conditioning system is installed in the new Westinghouse building at Emeryville, Calif., shown above.

New Anthracite Committee Meets

PRIMOS, PA.—The initial meeting of the anthracite equipment sub-committee of the ASHVE solid fuel committee was held at Anthracite Industries Laboratory February 16, with A. J. Johnson, director of Anthracite Industries Laboratory, presiding, and Ralph A. Sherman, supervisor of the fuels division of Battelle Memorial Institute and chairman of a similar bituminous equipment committee, in attendance.

Other committee members present included J. H. Kerrick of Philadelphia & Reading Coal & Iron Co., M. A. Young of Dickson & Eddy, and A. A. Norrman of D. L. & W. Coal Co.

The duties of this committee include the collection and correlation of information on anthracite and anthracite-burning equipment, the development and proposal of minimum performance specifications, and detailed cooperation with other research agencies.

Fungi in Air Harmful to Workers, New York Research Shows

NEW YORK—Molds and fungi encountered in daily life may be as harmful as mineral dusts in the air, according to a study by Dr. Adelaide R. Smith of the Division of Industrial Hygiene, New York State Department of Labor. Doctor Smith finds that these molds and fungi attack the respiratory track and result in diseases of the lung and serious systemic diseases.

Considerable attention is being given these days to industrial dusts which cause silicosis, but molds and fungi may be equally harmful and require their removal by ventilating systems. Doctor Smith reports that respiratory infections from fungi and molds are found among housewives and are also reported as an occupational disease among workers in tea factories, tea tasters, grape pickers, sponge cleaners, nut pickers, pigeon breeders, parrot fanciers, certain type of wig makers, house cleaners, grain handlers, agricultural workers, tobacco workers, peddlers of dried fruit, and straw handlers.

Molds, including fungi and yeasts, are filamentous plants of simple structure, differing from higher plant forms by the fact that they grow in irregular or undifferentiated masses instead of in structural formation with roots, stems, and leaves. They have no chlorophyl and consequently cannot obtain food from the carbon dioxide in the air but must obtain it ready made from living or dead organisms.

ASHVE Plans Big Summer Meeting

NEW YORK—The semi-annual meeting of the ASHVE will be held this year at Mackinac Island, Mich., July 4-6. The Michigan chapter of Detroit and the Western Michigan chapter of Grand Rapids will act as hosts to the society membership.

William G. Boales, Detroit, has been appointed general chairman of the meeting which will be known as the Great Lakes Summer meeting. He will be assisted by Frank Feely of the Michigan chapter and Tom Brown of the Illinois chapter, Chicago, whose special functions will be hosts and activity chairman on the boats plying between Detroit, Buffalo and Cleveland and Mackinac Island and from Chicago and Milwaukee and the Island.

O. D. Marshall, of the Western Michigan chapter, will be chairman of activities at the Island. The boat cruise through the Great Lakes to the Island is one of the features of the occasion although the convention place may also be reached by train and motor. Headquarters of the meeting will be at the Grand Hotel which has ample facilities for committee meetings and general sessions. Details of the program are yet to be announced.

Anthracite Conference Program Announced by Lehigh U.

BETHLEHEM, PA.—The program for the Second Annual Anthracite Conference of Lehigh University, to be held here April 28-29, has been announced. Merchandising methods, anthracite in the home and industry, combustion characteristics, uses of anthracite, mining and preparation, and the economics of anthracite will be discussed in papers to be delivered by 17 authorities.

The opening of the program Friday morning, April 28, will be devoted to the merchandising of anthracite, with E. E. Finn delivering a paper on Design of Retail Coal Yards, and R. W. Disque discussing Modern Merchandising of Anthracite. A section devoted to anthracite in the home will include Planning the Modern Anthracite Home, by T. I. Coe, technical secretary of the American Institute of Architects; Anthracite for Warm Air Heating, by A. P. Kratz, research professor, University of Illinois; and The Expanding Domestic Anthracite Market, by Allen J. Johnson, director, Anthracite Industries Laboratory.

Friday afternoon will be devoted to three general groups—anthracite in industry, uses of anthracite ash, and combustion characteristics. Included in these will be The Design of Semi-Industrial Stokers for Anthracite, by R. A. Krauss, Anthracite Industries Laboratory; Correlation of Coal Sizes to Mechanical Equipment, by P. A. Mulcey, assistant director, Anthracite Industries Laboratory, and Burning Characteristics of Anthracite, by P. Nicholls and B. A. Landry of the Bureau of Mines.

Saturday morning's session will be opened with papers on economic phases, as K. C. Richmond, editor of *Coal Heat* discusses Midwest Markets for Anthracite, and Dr. Neil Carothers, Dean of the Lehigh University College of Business Administration, speaks on Some Economic Aspects of Anthracite. The Conference will close with two papers on mining and preparation.

More A.C.Cars for Canadian Railway

MONTREAL—The Canadian National Railways have announced from their head office here that they will proceed in the near future with an extensive program of car building. Included in the tentative list of 2000 new cars are many air conditioned passenger, sleeping, and parlor cars, as well as refrigerated freight cars.

Attic Fan Sales Increased in 1938

NEW YORK—According to C. E. Greenwood, commercial director of Edison Electric Institute, attic ventilating fans to the number of 10,946 were sold in 1938 as compared with 8,522 in 1937.

Factory Code to Cover Ceramics; N.Y. to Amend Silicosis Rules

NEW YORK—Included in the program for 1939 of the Board of Standards and Appeals of the New York State Department of Labor is the revision of the boiler code, adoption of a code for the ceramics industry to minimize the silicosis hazard, and the adoption of rules for workers in mines and tunnels and relating to the removal of toxic fumes after blasting and the removal of fog and mist.

The New York State Industrial Code includes the ASME Boiler Code which was adopted in 1934. Since 1935, however, the ASME has modified the code from time to time and these modifications have not been placed in effect in the New York code. It is proposed to do this during the coming year.

With the completion of the code for the ceramics industry all the major industries and processes affected with silicosis hazard will have been covered by silicosis code rules. Rules for workers in mines and tunnels were prompted by the extensive underground operations in the Metropolitan area in connection with the water supply for the city of New York.

Fuel Oil Consumption Up 18% in '37

WASHINGTON—According to the petroleum economics division of the U. S. Bureau of Mines, the heating of buildings required 116,583,000 barrels of fuel oil in 1937, or more than 26% of domestic sales of oil for all purposes. Heating oil deliveries in 1937 were approximately 18% over the 1936 total, which compares with a 29% gain in 1936 over 1935. The lower rate of increase in heating oil consumption in 1937 is partly due to adverse business conditions in the latter part of that year and the accompanying decline in new burner installations; however, mild weather and increasing competition from automatic burners using other fuels were also factors.

The sales of light heating oils, Grades 1-4, used for domestic or household heating, increased from 69,859,000 barrels in 1936 to 81,201,000 barrels in 1937, while the heavy or residual fuel oils, Grades 5-6, commonly sold for heating larger buildings, increased from 29,398,000 barrels in 1936 to 35,382,000 barrels in 1937. An attempt was made in the 1937 survey to have the oil companies show their heating oil sales by individual grades, Nos. 1-6. This information was obtained for all states except those in the Pacific coast marketing area, where a breakdown was reported only between light and heavy heating oils. Consequently, national totals for the several grades of heating oils cannot be presented because of the lack of complete data for that one area.

Bill Would Prohibit Bid Peddling on Massachusetts Public Work

BOSTON—A bill entitled "An Act to Provide Fair Competition for Bidders in Construction of Public Works" is now before the Massachusetts Senate for consideration, presented by the Massachusetts State Building and Construction Council. It is important to heating, air conditioning, and plumbing contractors, because of its provisions which will prohibit the peddling of sub-bids on public works projects. It does not apply to private contracts.

The act provides that every contract for the construction, reconstruction, remodeling or repair of any public work by the state, county, city, town or district estimated to cost more than $5000 shall be awarded on the basis of competitive bids to the lowest responsible and eligible bidder. It defines who shall be considered responsible and eligible bidders and prescribes the formalities for submitting bids and bid deposits by general contractors.

Bids from the general contractor shall be for the complete project as specified and shall include all principal and such minor sub-contractors as are designated in the proposal form. All principal and sub-contractors shall deliver or mail to the awarding authority record copies of all bids sent by them to the general contractor. No other sub-bids will be considered by the awarding authority and the proposal may not be used by any other general contractor without the bidder's consent. No sub-bidder not included in this list of the awarding authority shall be used by the general contractor in his bid.

If a general contractor customarily performs with his own employes any sub-trade or trades listed in the proposal, he may submit a sub-bid under the same conditions as a sub-contractor, but must show to the satisfaction of the awarding authority that he customarily performs and is qualified to do the work required by the specifications.

Illinois Sponsors 5th Coal Course

URBANA, ILL.—The Department of Mining and Metallurgical Engineering of the University of Illinois will sponsor the Fifth Short Course in Coal Utilization here May 23-25. The course will be in charge of Prof. A. C. Callen, head of the department, with H. P. Nicholson, assistant professor of mining engineering, as chairman of the program committee.

Biggers Admitted to Toledo Firm

TOLEDO—Mills, Rhines, Bellman & Nordhoff, Inc., architects and engineers, have admitted Reeve Kelsey Biggers to partnership in the firm.

Texas to Hold 3rd A.C. Conference

AUSTIN, TEX.—Plans for the Third Annual Conference on Air Conditioning, to be held at the University of Texas here April 14-15, are based on a program intended primarily to help the profession as well as the user. Requirements and practices in connection with air conditioning in the southwest are peculiar to this region and case problems and papers on the installation and servicing of air conditioning are included. The following papers are to be presented at the Conference:

APRIL 14
p.m.

Summer Comfort Cooling Requirements for the Southwest, A. J. Rummel, San Antonio Public Service Co. Discussion, led by H. E. Degler.

Fan Selection and Use of Ducts, J. R. Bishop, American Blower Corp. Discussion, led by G. R. Rhine.

Heat Chart Method for Determining Conditions in an Air Conditioning System, also as an Aid for Selection of Equipment, E. P. Renouf, Westinghouse Co. Discussion, led by O. W. Bynum.

APRIL 15
a.m.

Case Problems of Air Conditioning, Dale S. Cooper. Discussion, led by O. G. Floyd.

Installation, Maintenance, and Service of Air Conditioning Systems, John B. Groseclose. Discussion, led by M. L. Diver.

Installation and Servicing of Air Conditioning Equipment of less than 50 Tons, A. F. Avera. Discussion, led by Hal Gibson.

OBI Annual Meeting Date Changed

NEW YORK—The program committee of Oil Burner Institute consisting of Earl Marr, chairman, Herbert Gillis and Larry Knapp, reports that the date of the annual meeting, which will be held at the Hotel New Yorker, New York, has been changed from April 17 to April 18. The events of the day will comprise a meeting of the board of directors in the morning and a group luncheon. In the afternoon the annual meeting will be held at which expiring directorships and vacancies on the board will be filled. The organization meeting of the new board of directors will take place following the annual meeting and officers and members of the Executive Committee elected for the ensuing year.

It is planned as well for the Metropolitan New York dealers to have a rally at the New Yorker in the afternoon. The program for this dealer meeting has not been developed but it is understood that the agenda will deal with matters that are timely and important for the welfare of the industry in this market. Complete information will be available later.

The Institute's 15th annual dinner is scheduled for 7 p.m. Attendance will comprise oil burner and accessory manufacturers and dealers. Representatives of oil companies and the Old Timers Club will also participate.

Sommers is New Head of A.C. Bureau

BOSTON—Officers for 1939 were elected at the February 15 meeting of the Air Conditioning Bureau, as follows: president, Rudolph Sommers; vice-president, Daniel Ricker; secretary, E. D. Johnson; treasurer, David M. Ramsay, Jr.; directors, L. S. Davis and O. A. Lawton.

Rudolph Sommers

Mr. Sommers is vice-president of the Boston Ice Company, in charge of real estate and engineering. He is a charter member and was treasurer of the Bureau for four years, and vice-president for one year.

Mr. Ricker has been secretary of the Air Conditioning Bureau since it was organized four years ago and more than any other one member has helped it to grow and become the influential organization that it is today in the air conditioning field. Mr. Johnson was treasurer last year. Mr. Ramsay is with the Westinghouse Boston organization.

The guest speakers were F. H. Munkelt, vice-president of the Consolidated Air Conditioning Division, W. B. Connor Engineering Corporation, who spoke on Odor Control by means of activated coconut shell carbon, and Frederick R. Ellis, consulting engineer with Burkel & Company, Inc., Boston, whose subject was the vital one of Basic Details of Air Conditioning Specifications. As a result of his talk, Mr. Ellis was appointed chairman of a committee to draw up a form which the Bureau would distribute to members and anyone bidding on installations.

Chicago Adds Theater Tonnage

CHICAGO—Two hundred and thirty tons of air conditioning were installed in theaters in Chicago during December, according to the Commonwealth Edison Company. All installations in this city during the month added up to 328 hp.

Gray Heads Utility A.C. Committee

NEW YORK—Edison Electric Institute has announced the names of members of its Air Conditioning Committee for 1939. The functions of this committee are: To give consideration to the technical developments of equipment and its effect on utility lines; to survey progress in development of this class of service in home, commerce and industry; to study the possibilities of room cooling with portable apparatus and its application in offices and homes; to consider the development of quarterly statistical information on sales progress.

Members of the committee are: Chairman, E. W. Gray, Oklahoma Gas & Electric Co., Oklahoma City; E. A. Freund, Union Electric Co. of Missouri, St. Louis; E. M. Jorgensen, Central Arizona Light & Power Co., Phoenix, Ariz.; G. L. MacGregor, Dallas Power & Light Co., Dallas; A. D. Marston, Kansas City Power & Light Co., Kansas City, Mo.; H. H. Mather, Philadelphia Electric Co., Philadelphia; C. H. Randolph, Wisconsin Electric Power Co., Milwaukee; S. S. Sanford, The Detroit Edison Co., Detroit; and R. H. Ten Eyck, Consolidated Edison Co., New York.

Plan Food Preservation Meeting

AUSTIN, TEX.—Plans for the Third Food Preservation Conference, to be held at the University of Texas here April 13-14 under the auspices of the University, with the cooperation of the ASRE, the A. & M. Engineering College of Texas and the Southwestern Ice Manufacturers Association, are complete.

Great interest is being shown in this meeting which will follow the pattern of the first and second conferences held in 1938. Papers presented at these food conferences and published by the ASRE have been much in demand, and interest in the whole subject of food refrigeration, especially in quick freezing and farmers' lockers, has grown rapidly in the last year.

Chairman of the conference is Byron Short, professor of mechanical engineering at the University of Texas, and his committee includes Carl J. Eckhardt, Venton L. Doughtie, Jennie Wilmot, Vernon T. Schuhardt and Dean W. R. Woolrich of the University; George E. Hulse, David L. Fiske, M. L. Diver and T. W. Carraway of the ASRE, L. P. Reiss of the SIMA and C. W. Crawford of Texas A. & M.

Michigan Engineers Hold Dance

DETROIT—The Michigan chapter of the ASHVE held its annual St. Valentine dinner-dance at Dearborn Inn February 11. There were 140 present including members, guests, and friends. F. J. Feely and G. D. Winans were co-chairmen of the committee.

Daly and Rose Added to Committee

NEW YORK—R. E. Daly, New York, and H. J. Rose, research fellow of the Mellon Institute, Pittsburgh, are new 1939 members of the committee on research of the ASHVE.

Following the first organization meeting the following were elected members of the executive committee of the research committee for the year: A. E. Stacey, Jr., vice-president of Buensod-Stacey, New York; T. H. Urdahl, consulting engineer, Washington; J. H. Van Alsburg, Chicago; J. H. Walker, Detroit Edison Company, and W. L. Fleisher who is chairman of the general committee.

Among research projects approved at the beginning of the year, in addition to many already in force, were new cooperative agreements with the University of Pennsylvania to study psychrometry under Prof. John Goff, and a project for the investigation of sound control with Massachusetts Institute of Technology. Studies of cooling towers at the University of California and of Heat Flow through walls at Texas A. & M. College were authorized to be continued.

Dr. C.-E. A. Winslow, professor of public health and director of the Pierce Laboratory of Hygiene at Yale University, has been elected technical advisor to the committee on research. He assumes the position formerly filled by Dr. A. C. Willard, president of the University of Illinois, who served in that capacity for several years.

Chamber Attacks U.S. Oil Tax Bill

NEWARK, N. J.—Defeat of bills providing federal fuel oil taxation is urged by the legislative committee of the Newark Chamber of Commerce in communications forwarded to New Jersey's Congressional delegation and Representative Doughton of the House ways and means committee.

Signed by E. W. Wollmuth, executive vice-president of the Newark chamber, the communication declared: "These measures are designed to use the federal taxing power to increase the price of one commodity for the benefit of another commodity with resulting increases to the consuming public."

Steam Roller Heats 38 Apartments

LYNN, MASS.—When the boiler of the central heating plant of Joseph Smishkiss' four-story, 38-family apartment building here was condemned, the 75 tenants were left without heat while a new boiler was being installed during some of the toughest winter weather late in January. Superintendent of Streets Thomas Smith solved the difficulty for Smishkiss by hooking up the city's old steam roller to the apartment house steam pipes and when it got going the howling of the tenants subsided.

Contractor Secretaries Convene

ATLANTIC CITY—Managers and secretaries of the Heating, Piping and Air Conditioning Contractors National Association held a conference at the Ambassador Hotel here February 6-7. Louis T. Braun, Chicago, was chairman of the conference, and Paul J. Heenan, Pittsburgh, acted as secretary. Among the subjects and speakers were Membership, Joseph C. Fitts, New York, secretary of the National Association; Programs, F. D. Mensing, Philadelphia; Separation of Contracts, William J. Olvany, New York; State Legislation, Harry Geiser, Newark; Apprenticeship, A. Bachman, Cincinnati; Labor Agreements, R. B. Miller, New York; Government Regulation, Paul J. Heenan, Pittsburgh; Activities of the Building Trades in Washington, William Stecher, Washington; State Fair Trade Practice Acts, J. E. McNevin, Denver.

Walker and Eder Open Laboratory

NEW YORK—Kirby Walker and James Eder have organized the firm of Walker and Eder to do business in special controls, orificing, vacuum tube relays, and other activities relating to heating systems and controls. Mr. Walker is responsible for several inventions and practices having to do with heating systems while Mr. Eder has been active in the refrigeration and air conditioning fields. Both formerly were connected with development work of the American Radiator Company. They have taken over their former laboratory facilities, and announce that with their complete equipment they can also handle the calibrating of instruments.

Boston Conditioning Up 33% in '38

BOSTON—According to figures compiled by the Air Conditioning Division of the Boston Edison Company, installations during 1938 increased over those of 1937 by 33%, and included more than thirty different types of applications. These cover, of course, many restaurants, but in addition a banquet hall, two churches, and seven industrial installations, as well as a barber shop at North Station. Five more hospitals installed air conditioning for the whole or a part of their rooms while the list of retail shops covers a wide range of business.

Fonda Opens Office in Baltimore

BALTIMORE—Bayard P. Fonda has opened offices at 513 North Charles St., where he will carry on a consulting engineering business in electrical and mechanical work, including air conditioning. Mr. Fonda was formerly connected with one of the large manufacturing organizations.

Midwest Conference Announced

CHICAGO—According to announcement by Dr. L. E. Grinter, dean of the graduate division and director of the department of civil engineering at Armour Institute of Technology, the Institute, in cooperation with seven middle western universities and colleges, is sponsoring the annual Midwest Power Conference to be held here April 5-7, in the Palmer House Hotel. Doctor Grinter is director of the conference.

This year's conference is the second to be held under the auspices of Armour Institute. Other educational institutions involved are Iowa State College, Purdue University, University of Illinois, State University of Iowa, University of Michigan, Michigan State College, and University of Wisconsin.

Cent per Gallon Oil Tax Proposed

WASHINGTON—Bill H.R.2886 was introduced into the House of Representatives recently by Representative J. H. Flannery of Pennsylvania, proposing a tax of 1 cent a gallon on fuel oil. This is the same bill that was introduced last year by Representative P. J. Boland and Mr. Flannery jointly. Representative Flannery's latest bill has been referred to the Ways and Means Committee.

Dr. Poulter Addresses Chicagoans

CHICAGO—Thomas C. Poulter, second-in-command of the Byrd Expedition to the South Pole and now Director of Research at Armour Institute, was the speaker at the January meeting of the Illinois chapter ASHVE, January 9. Doctor Poulter's subject was The Scientific Work of the Byrd Expedition in which he explained the methods of heating, ventilating, and sanitation used by the expedition.

Institute Spends Million on Building

WORCESTER, MASS.—A million dollar program of building and campus development has been authorized by the trustees of the Worcester Polytechnic Institute which includes erection and equipment of a new mechanical engineering building to cost $400,000; a memorial building for student activities, an auditorium, and other construction.

Burner Group Organized in Buffalo

BUFFALO—Seeking to stabilize the oil burner industry in this area, oil burner distributors have organized the Buffalo Oil Burner Association. Temporary officers are Joseph Collins, Frontier Engineering Co., chairman; Albert E. Stratton, Coleman-Stratton Co., and T. L. Anderson, Schwegler Bros., Inc., vice-chairmen.

Wants Central Heating in Housing

BIRMINGHAM, ALA. — The Alabama Coal Trade Extension Association is making efforts to have the government include a central heating system for both house heat and hot water in the new $4 million slum clearance project just begun here. In a previous project erected in this city for negroes no central heating was provided.

Larry W. Milner, consulting engineer for the organization, visited Atlanta where he investigated data on the central heating system in the Techwood housing project in that city.

Motz, Harbula Address Meeting

CHICAGO—The regular monthly meeting of the Chicago section of the American Society of Refrigerating Engineers, held in the Engineering Building Auditorium here February 1, was in the form of a joint session with the Chicago NAPRE. Included in the program were a lecture by W. H. Motz on The Ammonia Compression System and an address by M. G. Harbula, consulting engineer, Chicago, on Refrigeration, Refrigerants and Refrigerating Machine Drives for Air Conditioning.

Burner Installers May be Licensed

BOSTON—Bill No. 650 has been introduced by Representative F. X. Coyne in the legislature of Massachusetts to provide for the licensing of all persons engaged in the business of installing or servicing fuel oil burners. Under its terms, the license fee would be $5 annually and the work of installation would be done by licensed electricians, licensed plumbers, and licensed gasfitters.

A public hearing on this bill is scheduled here for March 14.

Plan to Double Weather Forecasts

WASHINGTON—The Weather Bureau is reported to be planning to double its forecast reports to the public after July 1.

It now makes two observations daily, in the morning and in the evening. These will be supplemented by observations at noon and midnight. The expansion was announced on the 69th anniversary of the Bureau's establishment.

Ohio Furnace Men Elect Officers

CLEVELAND—New officers were installed February 11 at a banquet in the Hotel Carter by the Warm Air Furnace and Air Conditioning League. They are: Robert Thompson, president; Jerry Bauman, vice-president; Irvine Lewis, secretary; Edward Stanek, Jr., J. J. Yacksow, Jr., Jack Kennedy, and Felix Dumas, trustees. The organization is made up of furnace and air conditioning men.

Journalists Inspect G.E. Laboratory

BLOOMFIELD, N. J.—Editors of trade, business, and technical papers attended the first editorial conference at the General Electric Air Conditioning Institute January 30 when the Bloomfield laboratory and new G. E. products were available for inspection. Announced at the same time was a plan whereby managers of the several air conditioning divisions are to tour the company's distribution points during a six-week period. It is planned to have the managers visit Dallas, Atlanta, Raleigh, Philadelphia, New York, Boston, Albany, Cleveland, Cincinnati, Detroit, Chicago, Kansas City, Minneapolis, Seattle, and San Francisco, during the period from February 2 to March 14. The tours are in charge of J. J. Donovan, manager of the air conditioning department.

Oil Tax Bill Introduced in Penna.

NEW YORK—House Bill No. 86 has been introduced in the General Assembly of Pennsylvania by Representative O'Connor, according to Oil Burner Institute. The Bill would require a tax of 3 cents a gallon on fuel oil sales. It has been referred to the committee on ways and means.

Pennsylvania has been the scene of numerous attempts to tax liquid fuel and there is some possibility that a tax may be enacted as a discriminatory measure in favor of coal.

Fair Adds to New York A.C. Systems

NEW YORK—Thirty-seven air conditioning installations totalling 747 hp. were added to the Manhattan lines of the Consoidated Edison Company of New York, Inc., during January. During the same month two installations totalling 23 hp. were added in the Bronx; 16 installations totalling 452 hp. were added in Queens, and six installations totalling 23 hp. were added in Brooklyn.

The large Queens total is due to the World's Fair which accounted for 14 installations totalling 436¾ hp.

Chicago Adds 401 Tons of A.C.

CHICAGO—Fifteen air conditioning installations totalling 401 tons were added to the lines of the Commonwealth Edison Company during the month of January, according to reports from that utility. The largest installation was a 150-ton job in the Admiral Theater, followed in size by a 115-ton installation in a candy factory. Of the 15 installations, five were food stores, three restaurants, two offices, two factories, while the others were single installations in a shoe store, theater, and bowling alley.

Boilers Subject of Bay State Bill

BOSTON—Further protection for users of domestic heating boilers is the objective of House Bill No. 340, now pending in the Massachusetts legislature. It is an amendment to an existing law and proposes not only to prohibit installation of boilers not equipped with an approved, reseating pressure and temperature relief valve in accordance with many plumbing codes, but also insists that no heating element shall be attached to an existing tank and no changes shall be made in existing connections which do not conform to the above provisions.

The valve would automatically release hot water in excess or 220F through a brass pipe or copper tubing of not less than ⅜-in. iron pipe size. Violation of this section would be punishable by a fine up to fifty dollars.

A.C. Subway Car Built for New York

BATTLE CREEK — A streamlined, air conditioned subway car, with aluminum body, its wheels cushioned in rubber, its seats upholstered in green mohair and its walls studded with mirrors, is being assembled here for its demonstration run in New York over tracks of the Brooklyn-Manhattan Transit System early in March. The car is being assembled in the shops of the Clark Equipment Company.

The car is equipped with a pressure ventilating system having large capacity blowers and filters. Thermostatically controlled heat from current produced by stopping the car is used for car heating. Two sets of interlocked control equipment are suspended from the body under-frame.

J. L. Shrode

ST. LOUIS—J. L. Shrode, president and founder of the Alco Valve Company, manufacturer of automatic control equipment, died December 31 from a cerebral hemorrhage. He was 58 years of age.

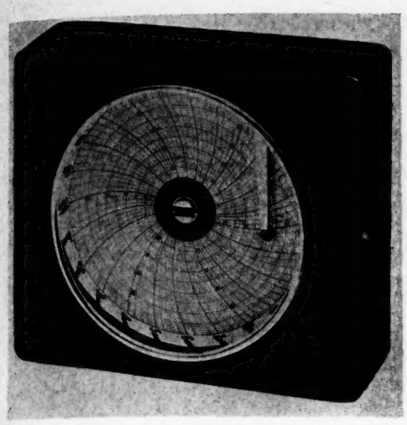
Mr. Shrode invented and patented an automatic constant pressure type valve in 1924, and in 1925 formed the Alco Valve Company. Mr. Shrode had been president of the company since that time.

Mr. Shrode was a member of the Rotary Club, Lions Club, ASRE, Engineer Council of St. Louis, and was a 32nd degree Mason.

Harold A. Matthews

CHICAGO—Harold A. Matthews, associated since 1924 with The Mercoid Corporation of this city, died January 30 from complications resulting from an accidentally discharged bullet while he was on a hunting trip New Year's Day. He was 49 years of age.

NEW EQUIPMENT

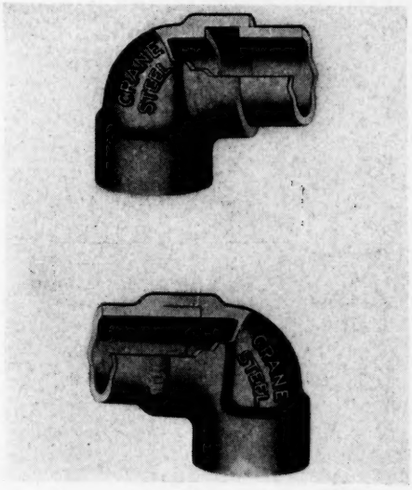


Marsh Recorder

NAME—Marsh Serviceman recorder.
PURPOSE—A compact recording thermometer or pressure gage.
FEATURES—This device can be used to record temperatures between 45 and 90F or 15 and 60F and pressures from 0 to 10 lb. A bimetallic spiral is used in the temperature recorder and a bourdon tube is used in the pressure recorder. The chart is rotated by a fully adjustable clock movement, wound by a knob extending through the back of the case. The pen arm has a friction hinge which permits it to be swung clear of the chart for chart replacement. The recorder is housed in a smooth cast-aluminum case with a satin black with chrome bevel finish. Included with the recorder are 100 charts and a bottle of ink.
MADE BY—*Jas. P. Marsh Corp., Chicago, Ill.* *1*

Crane Welding Sockets

NAME—Forged steel socket fittings for small welded lines.
PURPOSE—Pipe fittings for use with welded lines.
FEATURES—Fittings have a deep socket which makes possible a considerable amount of leeway in the assembling of pipe. On installations where the pipe need not butt against the shoulder at the back of the socket, it is unnecessary for the welder to cut the pipe to accurate length or to cut it off square. On installations where the pipe must butt against the shoulder, free uninterrupted flow can be assured. The manufacturer states that these fittings are especially designed for welding and the socket walls are proportioned to assure a uniform heat distribution and proper heat penetration. It is said that because the weld metal is deposited on the outer surface of the pipe, there is no danger of forming welding icicles which would clog the line and restrict flow. Fittings are made of either carbon steel or carbon-molybdenum and when used with steam, water, oil, or gas, the working pressures at 250F are 1700 lb. per sq. in. for the standard carbon steel fittings and 2550 for the extra strong carbon-molybdenum steel fittings. At a temperature of 1000F working pressures are 380 lb. for standard carbon steel fittings, 570 for extra strong carbon steel fittings, 540 for standard carbon-molybdenum fittings, and 810 for the extra strong carbon-molybdenum fittings.
PIPE SIZES—¼ to 2 in. in the following fittings: 45° and 90° elbow, tee, cap, coupling and reducer.
MADE BY—*Crane Co., Chicago, Ill...2*

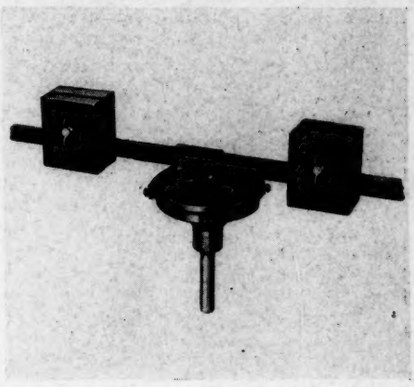


Industrial Service Soldering Flux

NAME—Special X soldering flux.
PURPOSE—A soldering flux for difficult-to-solder applications.
FEATURES—The manufacturer states that a lowered surface tension and good wetting power of flux causes a quick and uniform flow of solder into all cracks and crevices. It can be used on brass, copper, cadmium, stainless steels, zinc, monel, iron, and many other alloys.
MADE BY—*Industrial Service Laboratories, Milwaukee, Wis.* *3*

Minneapolis-Honeywell Boiler Regulator

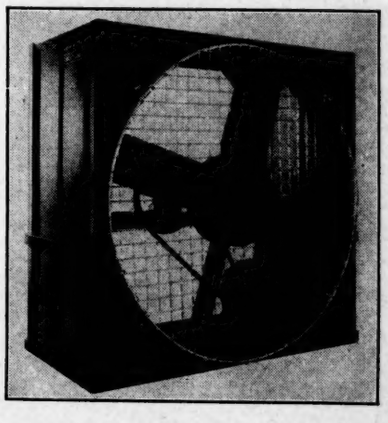
NAME AND MODEL NUMBERS—Metaphram steam boiler regulator, type M412A, and hot water boiler regulator, type M513A.
PURPOSE—To control the position of boiler draft and check dampers.
FEATURES—The diaphragms in these regulators are constructed of high grade brass which is not heated or spun in the manufacturing process so as to retain the resiliency of the brass. The regulators control the dampers by

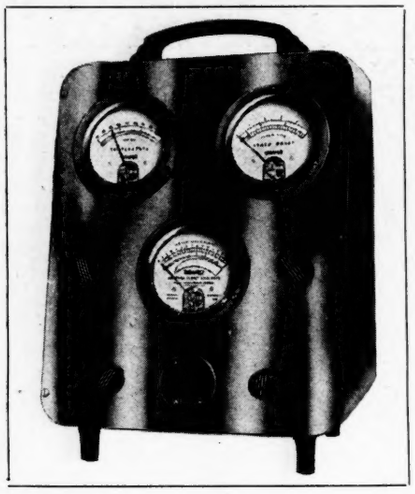


means of an external lever, which in turn is governed by either the steam pressure or water temperature in the boiler. The sensitive element of the hot water regulator may be replaced in case it becomes damaged.
MADE BY—*Minneapolis-Honeywell Regulator Co., Minneapolis, Minn....4*

DeBothezat Attic Fan

NAME—DeBothezat attic fan.
PURPOSE—An attic fan for ventilating buildings.
FEATURES—The steel housing of these fans is lined entirely with sound-absorbent material. A four bladed, die-formed fan wheel is mounted on the shaft which rotates on rubber mounted ball bearings. The fan is driven through a belt from a 1750 r.p.m. motor which is said to require lubrication only once a year. The entire unit is mounted on vibration-absorbent material and standard equipment includes a safety grille which can be mounted either in front or behind the fan wheel. Canvas adapters can be provided for use with suction boxes or ductwork.
SIZES AND CAPACITIES—Four sizes from 18 to 36 in. diameters; capacities ranging from 3000 to 12,000 c.f.m.
MADE BY—*DeBothezat Ventilating Equipment Div., American Machine and Metals, Inc., New York.* *5*



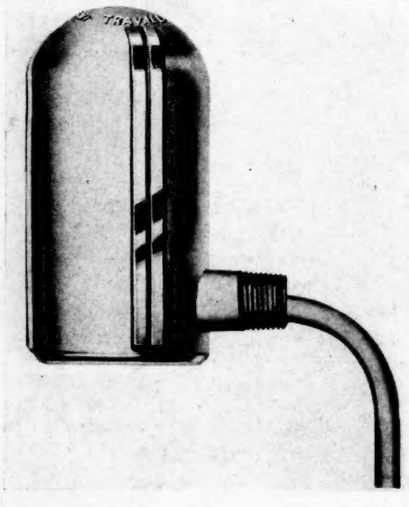


Weaver Heating Plant Analyzer

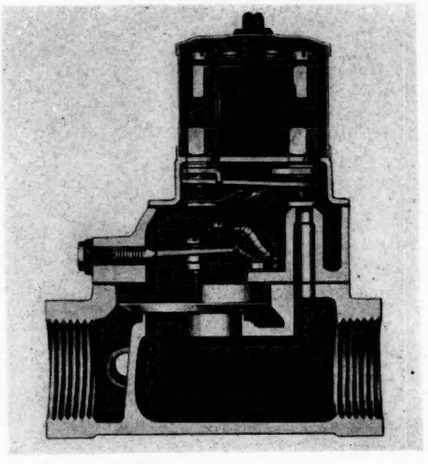
NAME—Heating plant analyzer.
PURPOSE—For analyzing combustion performance of domestic and commercial heating plants.
FEATURES—Instrument is a 3-in-1 unit that gives readings of stack draft, temperature and flue gas analysis. All three instruments operate from dry cells contained within the case and all three readings are simultaneous and continuous as long as gas sample is passed into the analyzer by the bulb aspirator. The temperature gage is an electric thermocouple with a range from 0 to 1000F. The stack draft gage is electrically operated and gives readings in hundredths of an inch of water, from 0 to 5/10 in. and the fuel gas analyzer operates on the Wheatstone Bridge principle to show the per cent of carbon dioxide by the thermal conductivity method.
MADE BY—*Weaver Manufacturing Co., Springfield, Ill.* 6

Marsh Air Valve

NAME—Marsh Travall.
PURPOSE—A low-cost valve for venting air from steam radiators.



FEATURES—Valve is of the non-adjustable type and utilizes the double wall construction formerly used in only the more expensive Marsh valves. Air is vented into the compartment formed by this double wall and leaves through a number of small ports in the outer shell. A large size float chamber is said to provide plenty of space for air and water separation, and the manufacturer states that this will eliminate spitting and float bobbing. The syphon pipe is designed to fit the narrowest radiator. Valve has a satin aluminum body with polished ribs.
TYPE AVAILABLE—⅛-in. angle pattern, ⅛-in. or ¼-in. straight pattern, and ¾-in. male straight pattern.
MADE BY—*Jas. P. Marsh Corp., Chicago, Ill.* 7

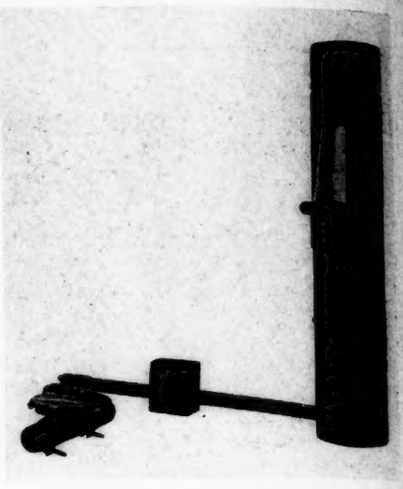


Friez Gas Valve

NAME—Slow-opening gas valve.
PURPOSE—A valve which regulates the gas flow to give a soft ignition at a low flame.
FEATURES—Valves incorporate a snap primary flow of adjustable volume, a hesitation period, allowing time for uniform draft to be established, followed by a slow opening to full capacity. This is said to provide a soft ignition at low flame followed by a gradual opening to full flame. The closing cycle is snap-acting. Valve operates on 20 volts.
SIZES—¾ and 1 in. pipe tap.
MADE BY—*Julien P. Friez & Sons, Baltimore, Md.* 8

Minneapolis-Honeywell Tank Heater Regulator

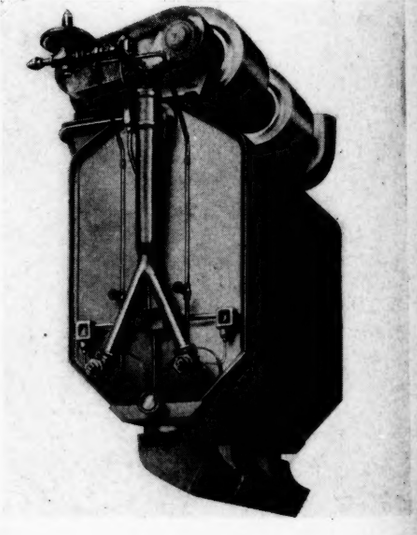
NAME AND MODEL NUMBER—Metaphram tank heater regulator, type M509A.
PURPOSE—A regulator for controlling the draft on hot water heaters.
FEATURES—Regulator is designed to prevent overheating of the heater and to reduce the number of firing periods. The regulator clamps on the hot water pipe by means of straps, thus eliminating the need of draining the water

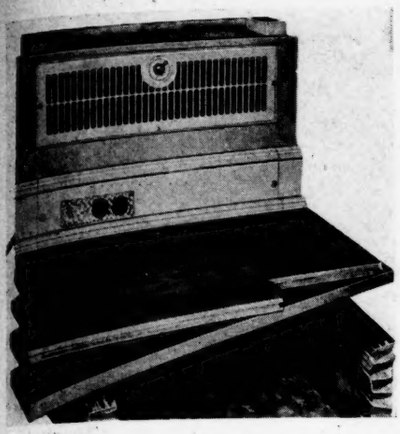


system at the time of the installation. It is normally installed on the pipe line between the heater and the tank which supplies hot water to the tank. The lever arm of the regulator is marked so that it may be set for the desired water temperature.
MADE BY—*National Regulator Div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.* 9

Lee Unit Heater

NAME—Lee suspended type unit heater.
PURPOSE—A high capacity suspended type gas-fired unit heater for use in large industrial buildings where high velocity heated air is desired to heat rooms of large floor area or high ceilings.
FEATURES—Unit will operate on natural gas, manufactured gas, or coke oven gas and is 3 ft. wide, 5 ft. long and 7 ft. high. It weighs about 3000 lb. and is of welded steel construction. The air discharge is 5500 c.f.m. with an average temperature rise of 110F. Air velocity at heater outlets is 2000 f.p.m.
CAPACITIES—500,000 B.t.u. per hr. output.
MADE BY—*Dravo Corp., Machinery Div., Pittsburgh, Pa.* 10

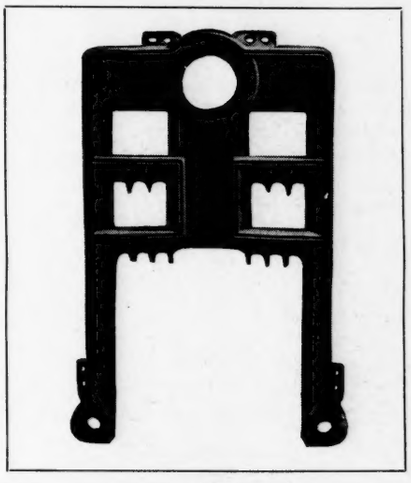




Supply unit of the Cond-Atmos system.

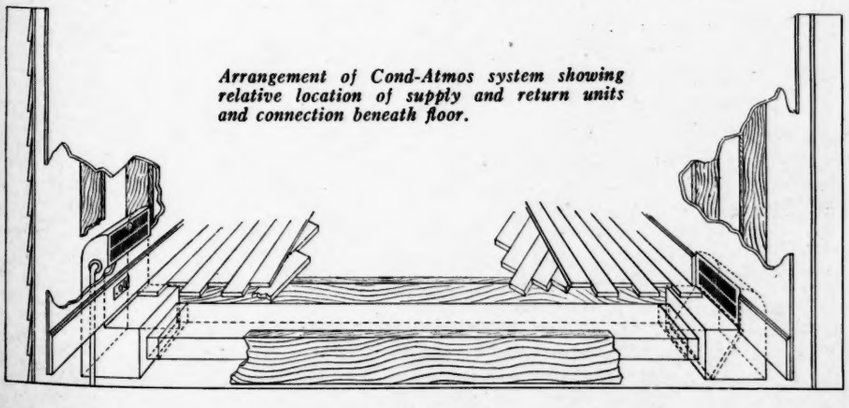
Cond-Atmos Air Conditioner

NAME—Cond-Atmos air conditioning system.
PURPOSE—Heating, humidifying, filtering and circulating air in new or existing homes, stores, or apartment buildings, in connection with radiator heat.
FEATURES—A concealed air conditioning unit for use with either steam or hot water and located in the room to be conditioned. The particular feature of the device is that it makes possible air conditioning of one or more rooms in any building in connection with a radiator heating plant without the use of a duct system or cutting of the building frame. Consequently, it gives the piping contractor a pre-engineered unit for a complete winter air conditioning system. The device consists essentially of one unit made up of extended heating surface, a humidifier, motor and blower, automatic controls, and an outlet grille located between the studding on one side of the room and connected by a simple duct between the joists in the floor with the other unit which consists of a cold air inlet grille and filter located on the opposite side of the room. Where local ordinances require it, a duct is used, but otherwise the channel between the floor beams is used Each conditioner comes in two packaged units—a supply and return. The necessary connections include only those to the steam or water system and electrical connections. Humidification is from the heating system. Since each unit has individual controls, separate room control of both temperature and humidification is available in a multi-unit installation. Very low noise level is claimed for the device. Throw-away type filters.
SIZES AND CAPACITIES—Available in one model with capacities ranging from 20 to 70 sq. ft. of steam radiator e.d.r. or equivalent in water, depending on adjustment on the job. Air circulation up to 200 c.f.m.
LITERATURE AVAILABLE—Catalog.
MADE BY — *Cond-Atmos Corp., New York*.....*11*

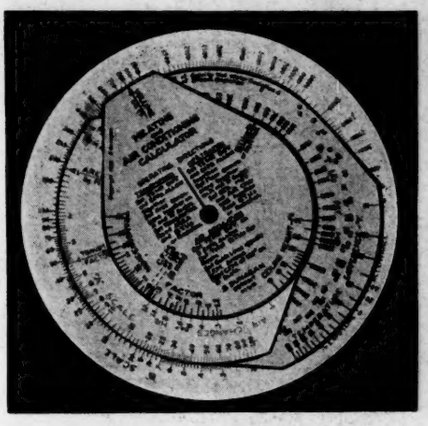


Burnham Boiler

NAME—Burnham Yello-Jacket boiler.
PURPOSE—For supplying steam or hot water using oil, gas, or coal as a fuel.
FEATURES—The manufacturer states that this boiler will operate with a small chimney and that it is designed to retard the flow of flue gases so as to cut down chimney loss due to intermittent firing of oil, coal, or gas. The surfaces upon which the fire shines have been extended to increase the fuel economy. The boiler is enclosed in a light yellow jacket which can be made to totally enclose an oil burner.
MADE BY—*Burnham Boiler Corp., Irvington, N. Y.*.....*12*



Arrangement of Cond-Atmos system showing relative location of supply and return units and connection beneath floor.



Dunagan Calculator

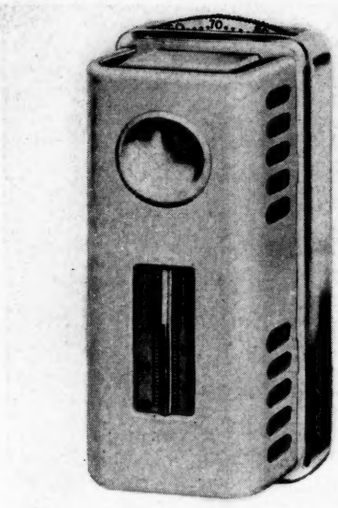
NAME—Dunagan heating and air conditioning calculator.
PURPOSE—For calculating heat loss or heat gain of rooms, steam or hot water radiator sizes, air supply and fan capacities in warm air systems and air systems for attic cooling jobs.
FEATURES—Calculator is of the circular type, 5 in. in diameter and consists of four celluloid discs. Operating directions are given on the face of the calculator while on the back are various data on transmission coefficients, infiltration losses, exposure losses, design temperature differences and duct losses. In all but one problem all settings are in plain view and can be checked at a glance.
MADE BY—*S. V. Dunagan, Detroit, Mich*.....*13*

Post Pencil-Tex Cloth

NAME—Pencil-tex.
PURPOSE—Drafting cloth for pencil.
FEATURES—The manufacturer claims that this cloth will give a sharp uniform ink-dense line with even the hardest of pencils. This line intensification, it is said, together with the glass-like transparency of the paper permits the production of blueprints with the sharp contrast of prints made from fine tracings. The manufacturer offers a try-it-yourself kit to interest the drafting supply users.
MADE BY—*The Frederick Post Co., Chicago, Ill.*.....*14*

McCord Gas-Fired Unit Heater

NAME—McCord gas-fired unit heater.
PURPOSE—For supplying warm air utilizing gas as a fuel.
FEATURES—The combustion chamber is equipped with a cast headsheet and deep flat tubes which are made of special material and designed to give maximum heating surface. Units are entirely self-contained and are equipped with controls for automatic operation.
SIZES AND CAPACITIES — Three sizes with capacities ranging from 63,000 to 150,000 B.t.u. per hr. input; air volumes from 1350 to 2250 c.f.m.
MADE BY—*McCord Radiator & Mfg. Co., Detroit, Mich.*.....*15*



Friez High Voltage Controls

NAME—Friez Hydraulic Action high voltage controls.
PURPOSE—A line of room thermostats, oven controls, and space thermostats which can be connected directly to the line and can handle high loads.
FEATURES—These new controls feature the new "Hydraulic Action" and have a solid liquid charge which actuates the switch contact. The manufacturer states that loads up to 25 amperes can be carried. A variety of types of controls are available for many types of applications.
MADE BY—*Julien P. Friez & Sons, Baltimore, Md.* *16*

Frick Unit Air Conditioners

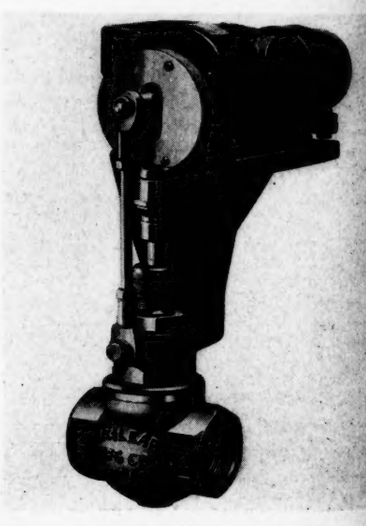
NAME—Frick unit air conditioners.
PURPOSE—For cooling buildings such as restaurants, tap rooms, stores, offices, etc.
FEATURES—The cabinets of these units are sound-insulated throughout and all moving parts are mounted on rubber. The refrigerating system is of the heavy-duty slow-speed type and utilizes a water-cooled motor and special condenser with the cold water on the outside to carry away the heat generated in the machine compartment. Space is provided for the addition of heating coils for winter operation.
SIZES AVAILABLE—Two sizes, 3 to 5 tons.
LITERATURE AVAILABLE—Bulletin No. 520.
MADE BY—*Frick Co., Inc., Waynesboro, Pa.* *17*

Taylor Hygrometer

NAME—Taylor Hygrometer.
PURPOSE—For indicating the dry and wet bulb temperature of the air in ducts, dryers, and other closed compartments.
FEATURES—Instrument is so designed that all parts are readily accessible for installation and routine servicing. By loosening two thumb screws the complete assembly swings out on a triple-hinged bracket. To increase the efficiency, the wet and dry bulbs have been staggered and can be used either in horizontal or vertical ducts. A skeleton guard around the bulbs prevents breakage and is so designed as to have no heat capacity to alter the temperature of the air around the bulb or to hinder the free circulation of air. The thermometer stems have the scales etched to give easy reading. The required opening in the duct for installation is 8 x 2¾ in. In operation water is supplied the wick by filling the water bottle and inverting it in the bottle holder which is designed to take the regular stubby beer bottle. When a pressure of more than ½ in. of water makes the bottle-fed hygrometer impractical, there is available a hygrometer with a constant-level reservoir. Space required for installation of this is 4 x 8 in.
MADE BY—*Taylor Instrument Companies, Rochester, N. Y.* *18*

McAlear Motor Operated Valves and Dampers

NAME—Electric motor operated valves and dampers.
PURPOSE—For opening and closing all kinds of valves by either automatic or remote control.
FEATURES—The motor equipment can be swung to any position on the valve, either in line with the pipe or at right angles to it and will operate in any position. Equipment is made both for on and off and reversing. The reversing type can be used for throttling a valve by the use of push-button control or automatic control. The motor does not contain any automatic positioning device. Positioning equipment must be a separate, automatic device. Motor is of high torque and various speeds from 15 sec. to 3½ min. per stroke. It is equipped with spring tension device to hold the valve disc tight on its seat to take up air and dirt, and is also equipped with a safety clutch to prevent damage to the motor when foreign matter lodges in the valve. This clutch also permits hand operation should the electric power not be available. The valve stem thrust cam is full ball bearing and grease packed.
SIZES AND CAPACITIES—Can be furnished for any kind of valve except plug valve in sizes ½ in. to 6 in. inclusive. Torque rating, based on 90 sec. stroke, 18 ft.-lb. using both 110 volt and 24 volt, 60 cycle a.c. shaded pole motor.
LITERATURE AVAILABLE—Bulletin M-1600.
MADE BY—*The McAlear Mfg. Co., Chicago, Ill.* *19*



TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below circle the item number of the equipment in which you are interested, using the number found at the end of each item.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

(This service available only to engineers or executives)

Fill in your name and address, detach and mail to
HEATING & VENTILATING, 148 Lafayette St., New York, N. Y.

Name.....
Title.....
Firm.....
Business Address .....
City and State 3/39

Rectangular Pipe Freezes

300,000 Pounds of Horse Meat for Fox Farms

Faced with the job of designing equipment to freeze and store 300,000 pounds of horse meat for the fox farm of Herbert A. Neiman & Co., the Vilter Mfg. Co. of Milwaukee decided on Youngstown rectangular pipe made up in their patented high economy coils. Because of its flat shape, the pipe can be used as shelving which carries the refrigerant, and so freezes quicker and more efficiently.

The rectangular pipe used in fabricating this refrigerating system carries ammonia gas under pressures ranging from 150 pounds to 15 inches vacuum and temperature changes from 60° to 50° minus. Because of closely controlled manufacturing processes coupled with rigid inspection practices the Youngstown rectangular pipe -- 56,160 feet of it -- used in this unusual installation was found admirably suited for the service for which it is being used.

The pipe was welded into 40' lengths and placed side by side to make shelves. In the top side at each end a 1¼" X.H. Nipple is welded from one pipe to the length above it. This fox farm uses 25,000 pounds of horse meat a day, and because of the dependability of Youngstown pipe, the foxes have never missed a meal.

There are many ways you can use Youngstown Rectangular and Square Pipe to save money and time, help you make a better job. Write for complete data.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - YOUNGSTOWN, OHIO

Ask your distributor for Youngstown Pipe and Tubular Products - Conduit - Sheets - Plates - Tin Plate - Bars - Rods Wire - Nails - Tie Plates and Spikes 27-1A

RECTANGULAR YOUNGSTOWN TUBING

Degree-Day Figures for January, 1939

HEATING & VENTILATING continues its eleventh year of publishing degree-day data for various large cities

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for January, 1939.....	1332	577	838	479	1147	1201	1495
Degree-days, Sept. 1, '38 to Jan. 31, '39	3818	1654	2303	1463	3079	3444	4280
Degree-days, Sept. 1, '37 to Jan. 31, '38	3736	2071	2600	1841	3342	3887	4411
Degree-days, Sept. 1 to Jan. 31, Normal	3726	1813	2619	1502	3280	3612	4202

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for January, 1939.....	1144	1039	848	1005	922	979	1060
Degree-days, Sept. 1, '38 to Jan. 31, '39	3942	3123	2553	2919	2763	3125	3228
Degree-days, Sept. 1, '37 to Jan. 31, '38	3950	3806	3218	3515	3368	3049	3976
Degree-days, Sept. 1 to Jan. 31, Normal	4104	3487	2795	3366	3133	3355	3762

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for January. 1939.....	1153	828	1543	598	1068	746	1042
Degree-days, Sept. 1, '38 to Jan. 31, '39	3366	2580	4920	1599	3085	2231	3136
Degree-days, Sept. 1, '37 to Jan. 31, '38	3953	2942	5482	1443	3672	2854	3850
Degree-days, Sept. 1 to Jan. 31, Normal	3584	3068	5161	1667	3336	2494	3405

	Fort Worth, Tex.	Grand Rapids, Mich.	Green Bay, Wis.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Ithaca, N. Y.
Degree-days for January, 1939.....	444	1129	1300	1030	1166	906	1195
Degree-days, Sept. 1, '38 to Jan. 31, '39	1332	3278	3918	2945	3204	2725	3582
Degree-days, Sept. 1, '37 to Jan. 31, '38	1553	3953	4653	3196	3482	3481	3850
Degree-days, Sept. 1 to Jan. 31, Normal	1406	3659	4420	3069	3316	3130	3706

	Kansas City, Mo.	Knoxville, Tenn.	La Crosse, Wis.	Lansing, Mich.	Lincoln, Neb.	Little Rock, Ark.	Los Angeles, Calif.
Degree-days for January. 1939.....	820	696	1247	1185	936	580	253
Degree-days, Sept. 1, '38 to Jan. 31, '39	2493	2068	3827	3590	2897	1703	515
Degree-days, Sept. 1, '37 to Jan. 31, '38	3151	2451	4491	4220	3530	2053	362
Degree-days, Sept. 1 to Jan. 31, Normal	2903	2298	4313	4001	3512	1798	750

	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.	Nashville, Tenn.	New Haven, Conn.
Degree-days for January, 1939.....	757	1200	560	1129	1404	635	1117
Degree-days, Sept. 1, '38 to Jan. 31, '39	2303	3713	1682	3432	4235	1950	3013
Degree-days, Sept. 1, '37 to Jan. 31, '38	2944	4486	2111	4106	4784	2459	3258
Degree-days, Sept. 1 to Jan. 31, Normal	2526	4258	1871	3984	4550	2175	3219

	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma City, Okla.	Omaha, Neb.	Peoria, Ill.	Philadelphia, Pa.
Degree-days for January, 1939.....	217	1013	611	623	993	1019	946
Degree-days, Sept. 1, '38 to Jan. 31, '39	709	2672	1696	1928	3072	3059	2532
Degree-days, Sept. 1, '37 to Jan. 31, '38	953	2938	2094	2360	3759	3785	2830
Degree-days, Sept. 1 to Jan. 31, Normal	735	2909	1933	2244	3639	3606	2736

	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.	Reno, Nev.	Richmond, Va.
Degree-days for January, 1939.....	911	1280	658	1141	992	894	697
Degree-days, Sept. 1, '38 to Jan. 31, '39	2738	3595	2183	3049	2803	3079	2082
Degree-days, Sept. 1, '37 to Jan. 31, '38	3254	3859	2115	3340	3028	2767	2479
Degree-days, Sept. 1 to Jan. 31, Normal	3003	3817	2530	3246	3102	3326	2232

	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.	Seattle, Wash.	Spokane, Wash.
Degree-days for January, 1939.....	1208	760	1006	404	1150	629	937
Degree-days, Sept. 1, '38 to Jan. 31, '39	3433	2311	3158	1252	3328	2242	3319
Degree-days, Sept. 1, '37 to Jan. 31, '38	3844	3026	2605	1167	3576	2201	3258
Degree-days, Sept. 1 to Jan. 31, Normal	3666	2798	3259	1414	3446	2656	3755

	Springfield, Ill.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for January, 1939.....	918	1218	1078	1025	1287	842	762
Degree-days, Sept. 1, '38 to Jan. 31, '39	2722	3472	3173	2810	3818	2399	2360
Degree-days, Sept. 1, '37 to Jan. 31, '38	3446	3726	3763	3044	4075	2712	2855
Degree-days, Sept. 1 to Jan. 31, Normal	3183	3768	3392	2774	3785	2711	2877

Methods of applying the degree-day in connection with the operation of heating plants or for the prediction of fuel consumption of heating plants are described fully in the new enlarged edition of the DEGREE-DAY HANDBOOK, published by HEATING & VENTILATING, 148 Lafayette Street, New York, price $3. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

One Heating System Must Satisfy *many* Viewpoints

Although Dunham Sub-atmospheric Steam Heating is almost unbelievably economical in operation, that is only a result of a complete cycle of values, *not the basic reason* for its selection. The additional values are each as necessary as the fingers of a hand and each fulfills an essential mission.

The Architect's viewpoint is met in this system's ability to match all weather vagaries with varied steam temperatures. Thus unvarying comfort is enjoyed with never a thought for valves or windows or of heating itself.

The Consulting Engineer values the sound engineering of the system, its precision manufacture, its broader use of the *full properties* of steam, and its simple installation, control and maintenance.

The Heating Contractor realizes that the conventional design of this system simplifies installation and quickens the delivery of a perfectly balanced plant.

The Operator finds a complete mastery of sudden weather variations. He can vary steam temperatures to keep room temperatures steadily at wanted level. This gives him fuel economy under controls which afford economy of effort as well.

To Management Dunham Sub-atmospheric steam offers the sum total of these vital values, economy and "rentability" for good return on investment, advanced engineering and precision-manufacture that the investment may be permanent, in a system that balances quickly, functions perfectly and equals, from all viewpoints, the most advanced concept of good heating. C. A. Dunham Co., 450 E. Ohio St., Chicago.

The Owner

"This building must have the carefree heating comfort of even temperatures that tenants insist on today in offices and apartments; it must be economical to operate and preferably automatic in operation."

The Architect

"The satisfactory heating system maintains comfort level temperatures in *all* weathers. It is economical both in operation and maintenance."

The Engineer

"The heating system must embrace sound engineering, a heat supply that exactly balances the heat demand under all weather variations with the minimum of manual control."

The Contractor

"The system should be simple in design and method of installing, easy to balance and service."

The Operator

"The best heating system maintains comfort temperature conditions whether it is ten below or sixty above and calls for the minimum of attention and of fuel or steam consumption."

Each of these viewpoints is satisfied in

The DIFFERENTIAL *System*

COMFORT CONDITIONING by DUNHAM

DUNHAM *Sub atmospheric Steam* HEATING

Rockefeller Center
is supplied with
Rust-free Hot Water by

Patterson

Copper-Lined Heaters

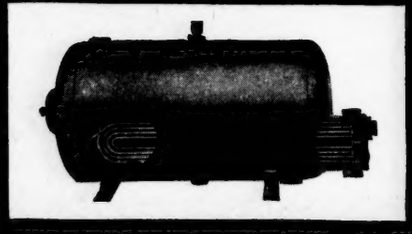
To insure the 25,000 tenants of the Rockefeller Center Buildings of a bountiful supply of rust-free hot water . . . even if they are in the 70 story R.C.A. Building, 850 ft. up in the air . . . 28 Patterson Indestructo Copper-Lined Hot Water Service and Storage Heaters were installed.

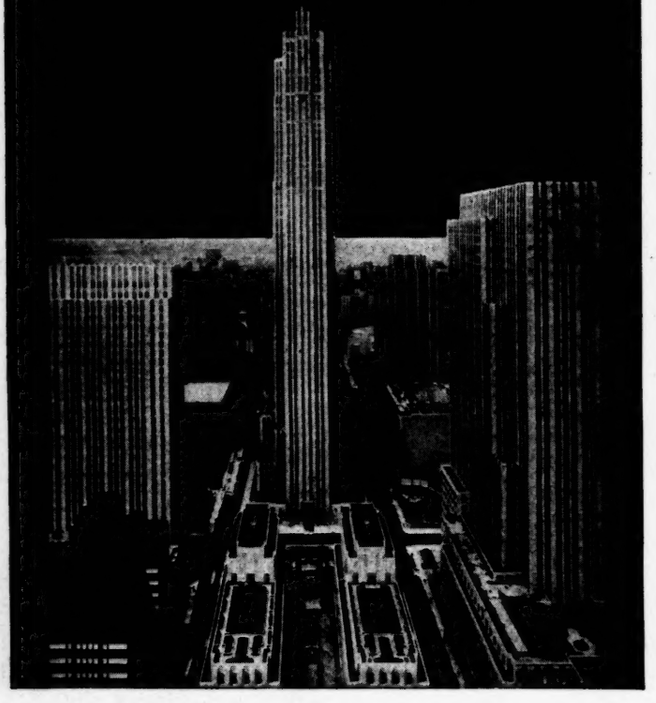
Be safe and specify Patterson Copper-Lined or Everdur Heaters. They are guaranteed not to cause rust or red water and to furnish all the hot water required, as hot as required and as quickly as required.

The architects for this gigantic structure were Corbett, Harrison & MacMurray, Hood & Fouilhoux and Reinhard & Hofmeister, and the Consulting Engineer, Clyde R. Place.

Write for our Catalog

The Patterson-Kelley Co., Inc.
105 Burson St., East Stroudsburg, Pa.





Bureau of Standards Issues Standards for Mechanical Draft Oil Burners

(Concluded from page 48)

17. Following installation of the burner certain test data shall be obtained and recorded by the installer on the Oil Burner Certificate to be placed with each oil burner installation. The test to cover the following points—CO_2, Draft, Stack Temperature, Firing Rate and Smoke.

18. The test procedure and standard requirements as approved by the industry are as follows (the test to be made in accordance with test procedure of Oil Burner Industry Standards Committee):

(1) *CO_2.* Minimum CO_2 shall be 8 percent.

(2) *Draft.* The draft shall be in accordance with specifications in the manufacturer's installation manual.

(3) *Stack Temperature.* Stack temperature shall be taken on the boiler side of automatic draft regulator and not more than 12 inches from the boiler smoke connection. Stack temperature shall be taken at the certified firing rate. Where automatic draft regulator is built into the boiler or furnace such regulator shall be closed tight at time of stack temperature reading.

(4) *Firing Rate.* Firing rate to be based on burner manufacturer's recommendation of oil rate for total connected load. Burner to be fired at that rate as a minimum, but not to exceed 25 percent additional for maximum firing.

(5) *Smoke.* During above test, there shall be no visible smoke at the chimney.

(6) *Installation Manual.* Burner to be installed in accordance with manufacturer's installation manual.

WITH THE MANUFACTURERS

Alco Valve Co., St. Louis, Mo., announces that *A. B. Schellenberg* was elected president and general manager at a meeting of the board of directors January 30. Mr. Schellenberg succeeds J. L. Shrode, founder and president of Alco, who died suddenly December 31. Mr. Schellenberg has been sales manager of the company for the past two years. He joined the company in 1929, four years after its founding, and worked first in the engineering department, later in the sales department. In 1932 he was made manager of the New York office and continued in that capacity until January, 1937, when he returned to St. Louis as sales manager.

John E. Dube, formerly with the Fulton Sylphon Company, has joined the engineering department to direct its new development program. For the past five years Mr. Dube has been in charge of design and development work at Fulton Sylphon.

American Radiator & Standard Sanitary Corp., New York, has announced that the manufacture and sale of the products of its subsidiaries—*American Radiator Company, Standard Sanitary Mfg. Co., American Gas Products Corporation, Ensign-Reynolds, Inc., Excelso Products Corporation,* and *The Fox Furnace Company* —have been unified and effective February 1 products of these companies will be manufactured and sold under the same trade names and trade marks directly by American Radiator & Standard Sanitary Corporation. The above mentioned subsidiaries have ceased to be operating subsidiaries.

Independent Air Filter Co., Chicago, has discontinued its business. Company affairs are now in liquidation and the process will be completed as rapidly as possible. Adequate arrangements have been made to complete all outstanding orders and continue all required service.

Johns-Manville Corp., New York, has elected *Robert W. Lea* vice-president in charge of finance. Mr. Lea was formerly president of the West Virginia Coal and Coke Company. He remains on the board of directors of that company, however.

The Kelley Manufacturing Co., Houston, Tex., has opened a new plant and two-story office building. Kelley purchased Tennison Manufacturing Company in 1937.

The Mercoid Corp., Chicago, Ill., announces that *J. A. Johnson* is now associated with its organization, with offices at 25 Ivy St., Boston, Mass.

John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa., has erected an addition to its plant at State Road and Rhawn St. The brick and concrete structure consists of two bays which will give an additional 15,000 sq. ft. of floor space.

Revere Copper and Brass Inc., Dallas Div., Chicago, has appointed *Keith C. Bowers* sales representative in western Missouri and Kansas, with headquarters at 325 Ward Parkway, Kansas City, Mo.

Todd Shipyards Corp., New York, announces the election of *Francis J. Gilbride*, formerly vice-president, as president of the Robins Dry Dock & Repair Co., Brooklyn, N. Y. *F. D. Hesley* was elected senior vice-president; *John J. Dement, William G. Robinson*, and *Herman Minikine* were elected vice-presidents. *F. D. Hesley, Sydney Urwin, John J. Fogarty, Joseph A. Seitz, Joseph Wilson*, and *William J. Sammon* were elected directors.

F. J. Gilbride

Ward Leonard Electric Co., Mount Vernon, N. Y., announces the change of address of its representative, *Mark G. Mueller*, to 1644 Blake St., Denver. Mr. Mueller represents Ward Leonard in Colorado, western Nebraska, northern New Mexico, and Wyoming.

Wheelco Instruments Co., Chicago, has appointed *C. W. Lugar* to the Indianapolis territory, with offices at 216 Indianapolis Terminal Warehouse. Mr. Lugar was formerly with Minneapolis-Honeywell.

York Oil Burner Co., Inc., York, Pa., has named *E. P. Ryan* divisional sales manager in the eastern territory. *A. L. Frank* has been appointed divisional sales manager in the southern territory.

NEW TRADE LITERATURE

Attic Ventilators. A standard-size, 10-page catalog, No. 1957, describing the Diehl line of attic ventilators. Describes construction features and gives data on capacities and dimensions of these units. Also gives suggestions as to installation and how to calculate the size of the system required. DIEHL MANUFACTURING CO., ELIZABETHPORT, N. J. 21

Boilers. A standard-size, eight-page circular illustrating and describing the Spencer Type A steel tubular boilers. These boilers are designed for oil, gas, stoker, or hand-firing of bituminous or anthracite. Presents information on design and construction features, also gives capacities and dimensions. SPENCER HEATER DIV., LYCOMING MFG. CO., WILLIAMSPORT, PA. 22

UNDER-GROUND INSPECTION

Burying steam pipes underground, and then hoping for the best, resembles the famous habit of the ostrich. The time to give steam conduit the "once-over" is BEFORE it goes into the ground, not after. Ric-wiL construction and Dry-paC Insulation are perfectly open to inspection before installation. Investigate, compare—before you buy!

Ric-wiL Conduit for steam power and heating lines is a sectional system built of vitrified, glazed Tile (also furnished in Cast Iron and in Armco Iron Units). Standard Ric-wiL is insulated with patented Dry-paC Waterproof Asbestos, but loose commercial insulation or sectional pipe covering may be had if desired. Ric-wiL with Dry-paC, as proved by reliable tests, gives over 90% efficiency on the line. Upper and lower halves of Ric-wiL Conduit are interlocked by the Loc-liP cemented joint. End joints of conduit and base drain are staggered—another interlocking feature. Ric-wiL provides adequate drainage and entirely closed construction. Complete service on layout, manufacture, and installation. Write for latest bulletins.

The RIC-WIL Co., Union Commerce Bldg., Cleveland, Ohio

New York **Chicago**

Agents in principal cities

● Ric-wiL Bulletin of Steam Heating Rates for 1939 now ready—write for your copy!

RIC-WIL Type F Conduit

REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

We are the three Williams' sons—Will, Willie and Bill. We will save you time and help you make more money on your gravity and air-conditioning installations through the use of

FAVOR-LOX prefabricated duct and fittings. Beautiful installations. No bolts or screws needed. No loose "S" Hooks or Drive Straps. Minimum of cutting. Dealers report installation time cut 50%.

FAVORITE—PIPE and fittings for gravity. Complete line, die-cut. No hammering. Perfect fit, good looking installations in less time.

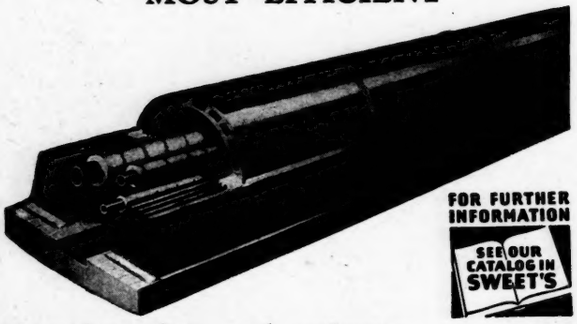
FREE—*Complete, easily understood short method for figuring air conditioning jobs. You can complete your figures and price job in one hour flat. Write—Dept. 5 for prices and catalogs.*

THE WILLIAMSON HEATER CO.
CINCINNATI, OHIO
TRIPL-LIFE Complete Line Quick Service FLO-WARM

THERM-O-TILE

The Conduit for Underground Steam Lines

SIMPLEST
STRONGEST
MOST EFFICIENT



Complete data and estimates on request. Sold and installed by Johns-Manville Construction Units in all Principal Cities.

H. W. PORTER & CO., INC.
825 FRELINGHUYSEN AVE., NEWARK, N. J.

Boilers. Two standard-size, four-page circulars describing Kewanee Type R round and square boilers. The first one, circular 93a, is printed in three colors, describes the use of these boilers for heating with oil or gas and gives specifications and measurements. Circular 93.80a describes Type R boilers for oil, gas, stoker, and hand-firing; also gives specifications and measurements. KEWANEE BOILER CORP., KEWANEE, ILL. 23

Motors. A standard-size, 26-page catalog, No. 39, describing Diehl line of electric motors, generators and equipment. Contains price information and application data on motors, generators, and ventilating equipment. DIEHL MFG. CO., ELIZABETHPORT, N. J. 24

Pipe Couplings. A standard-size, loose-leaf, 12-page bulletin, No. M-700, illustrating and describing the Raybould pipe coupling which is a coupling for making pressure-tight flexible connections on plain end pipe. Gives information on the various types of fittings available and also includes specifications and list prices. DISTRIBUTED BY PITTSBURGH EQUITABLE METER CO., PITTSBURGH, PA. 25

Refrigeration. A standard-size, loose-leaf catalog illustrating and describing the Sporlan "Controlled Performance" valves. Gives information on thermostatic valves for Freon, methyl chloride and ammonia; on solenoid valves for Freon, methyl chloride and sulphur dioxide and gives installation and servicing information. SPOEHRER-LANGE CO., ST. LOUIS, MO. 26

Unit Heaters. A standard-size, eight-page catalog, W-N 105, describing the Warren-Nesbitt Series F unit heaters designed for use in heating lobbies, offices, showrooms, and similar places where high capacity, neat appearance, and quietness are desirable. Gives information on construction features, capacities, control diagrams, dimensions and specifications. JOHN J. NESBITT, INC., HOLMESBURG, PHILADELPHIA, PA. 27

Warm Water Heating. A standard-size, four-page catalog entitled Taco Specialties for Warm Water Heating. Describes the following equipment: the "Taco-One" Venturi system, circulator, flow check, No. 100 control, relief valve, expansion tank, reducing valve and two-pipe system. Also gives piping diagrams and design information on the Venturi and two-pipe system. TACO HEATERS, INC., NEW YORK. 28

Welding. A standard-size, 16-page service bulletin on the welding of wrought iron. Bulletin describes the various processes and procedures for welding wrought iron and gives a considerable amount of data on manual oxy-acetylene welding procedure and manual metallic arc welding procedure. Also gives information on the physical properties of welds. A. M. BYERS CO., PITTSBURGH, PA. 29

TO OBTAIN COPIES OF TRADE LITERATURE listed in this issue, circle on the list below the publications wanted, using the item number at the end of each review; fill in your name and address, mail to

HEATING & VENTILATING
148 Lafayette St., New York, N. Y.

21 22 23 24 25 26 27 28 29

(This service available only to engineers or executives)

Name .....

Title .....

Firm .....

Business Address .....

City and State 3/39

COMING EVENTS

MARCH 23-25, 1939. Second Oregon State Air Conditioning Conference, Oregon State College, Corvallis, Oreg. General Chairman, Prof. E. C. Willey, Oregon State College.

APRIL 5-7, 1939. Midwest Power Conference, Palmer House Hotel, Chicago. Director, Dr. L. E. Grinter, Dean of Graduate Division and Director of Department of Civil Engineering, Armour Institute of Technology, Chicago, Ill.

APRIL 13-14, 1939. Third Food Preservation Conference, University of Texas, Austin, Tex. Chairman, Prof. Byron Short, University of Texas.

APRIL 14-15, 1939. Third Annual Conference on Air Conditioning, University of Texas, Austin, Tex. Chairman, Prof. H. E. Degler, University of Texas.

APRIL 28-29, 1939. Second Annual Anthracite Conference Packard Memorial Hall, Lehigh University, Bethlehem, Pa. Chairman, Committee on Arrangements, Prof. Howard Eckfeldt, Lehigh University.

MAY 19-20, 1939. Second Coal Conference, Washington University, St. Louis, Mo.

MAY 22-23, 1939. 26th Spring Meeting, American Society of Refrigerating Engineers, Hotel Hershey, Hershey, Pa. ASRE Headquarters, 37 West 39th St., New York.

MAY 23-25, 1939. Fifth Short Course in Coal Utilization, University of Illinois, Urbana, Ill. Chairman of Program Committee, Prof. H. P. Nicholson, University of Illinois.

MAY 24-26, 1939. Annual Convention, Association of Gas Appliance and Equipment Manufacturers, Hotel Roosevelt, New York. Association Headquarters, 60 East 42nd St., New York.

MAY 31-JUNE 2, 1939. 50th Annual Convention, Heating, Piping and Air Conditioning Contractors National Association, Drake Hotel, Chicago, Ill. Association headquarters, Room 1401, 1250 Sixth Ave., New York.

JUNE 1-2, 1939. Annual Convention, Stoker Manufacturers Association, French Lick Springs, Ind. SMA Headquarters, 307 N. Michigan Ave., Chicago.

JUNE 5-7, 1939. Mid-Year Meeting, National Warm Air Heating and Air Conditioning Association, Stevens Hotel, Chicago. NWAH & AC headquarters, 50 W. Broad St., Columbus, Ohio.

JUNE 5-8, 1939. National Association of Master Plumbers Convention, Minneapolis, Minn. NAMP headquarters, 917 15th St., NW., Washington, D. C.

JUNE 13-16, 1939. 33rd Annual Convention, Smoke Prevention Association. Hotel Schroeder, Milwaukee, Wis. An Exhibit of Fuel-Burning Equipment will be a feature. SPA headquarters, City Hall Sq. Bldg., Chicago.

JUNE 27-30, 1939. 30th Annual Convention and Equipment Exhibit, National District Heating Association, Hotel Pennsylvania, New York. NDHA headquarters, 1317 Spruce St., Philadelphia, Pa.

JULY 4-6, 1939. 45th Semi-Annual Meeting, American Society of Heating and Ventilating Engineers, Grand Hotel, Mackinac Island, Mich. ASHVE headquarters, 51 Madison Ave., New York.

OCTOBER 4-6, 1939. Exposition of Building, Industry and Services, Hotel Statler, Detroit, Mich. Sponsored by the Mortgage Bankers Association of America. George H. Patterson, Secretary-Treasurer, 111 West Washington St., Chicago, Ill.

OCTOBER 17-20, 1939. 68th Annual Meeting, American Public Health Association, William Penn Hotel, Pittsburgh, Pa. APHA headquarters, 50 West 50th St., New York.

JANUARY 22-26, 1940. 46th Annual Meeting, American Society of Heating and Ventilating Engineers, Cleveland, Ohio. To be held in conjunction with the 6th International Heating and Ventilating Exposition at the Cleveland Public Hall.

JANUARY 23-25, 1940. 35th Annual Meeting, American Society of Refrigerating Engineers, Hotel Cleveland, Cleveland, Ohio.

"Quiet, please..."

REDUCTION of the industrial noise factor has an ally in Webster-Nesbitt Unit Heaters. Their marked quietness is due to the way they are constructed as well as to proper care in their application to the job. Fans with especially wide, overlapping blades of gradual pitch are designed to eliminate eddy-current and blade-tip noises common to ordinary propeller fans. Proper spacing between fan and heating element provides a more uniform, quieter air flow; and rubber-isolated, slow-speed motors prevent the transmission of hum and vibration to unit casing and connected piping. Add to these *engineered application* by a trained Webster representative and you have an assurance of QUIET efficient operation that's bound to PLEASE.

SEND FOR CATALOG

Webster Nesbitt UNIT HEATERS

For high-roof structures and large interiors where a long drive of air is required you can depend on Webster-Nesbitt Giant Heaters, blower-fan type. Send for new catalog.

Manufactured by JOHN J. NESBITT, INC., Holmesburg, Phila., Pa.
Distributed Exclusively in the U. S. A. by WARREN WEBSTER & COMPANY, Camden, N. J.
Address Nearest Webster Sales Office—Consult Your Telephone Directory